A 000 030 292 7
UC SOUTHERN REGIONAL LIBRARY FACILITY

OXIDE OF ZINC
ITS NATURE, PROPERTIES AND USES.

J. CRUICKSHANK SMITH

ADVERTISEMENT

Apex

Elastic White Japan.

Made from the Finest and Purest Oxide of Zinc.

Most Beautiful White, Permanent Finish.

As glossy as Porcelain.

Manufacturers :

John Mathews & Co.,
Hatton Garden,
Liverpool,

Who will send Samples on application.

Mathews' Pure Liquid Paints.

IN WHITE AND ALL COLORS.

A signed Guarantee on each Tin. In ¼-gallon Handled Tins.

Telegrams—
" MATHEWS, LIVERPOOL."

Telephone—
" 784 CENTRAL " (3 Lines,)

Contractors to H.M. War Office and Admiralty.

OXIDE OF ZINC

"THE DECORATOR" SERIES OF PRACTICAL HANDBOOKS

No. 6.

Edited by ARTHUR SEYMOUR JENNINGS.

OXIDE OF ZINC

ITS NATURE, PROPERTIES & USES

WITH SPECIAL REFERENCE TO THE MAKING AND APPLICATION OF PAINT

BY

J. CRUICKSHANK SMITH, B.Sc., F.C.S.,

MEMBER OF THE SOCIETY OF CHEMICAL INDUSTRY,
MEMBER OF THE INTERNATIONAL TESTING ASSOCIATION,

AUTHOR OF

"*The Manufacture of Paint,*" *etc.*

WITH A CHAPTER BY

A. P. LAURIE, M.A., D.Sc.

London:
THE TRADE PAPERS PUBLISHING CO., LTD.,
365 BIRKBECK BANK CHAMBERS, W.C.

1909.

INTRODUCTION BY THE EDITOR

No apology need be offered for the publication of this little book, because although Zinc Oxide has been known and used for many years it is only comparatively recently that it has been regarded with such wide-spread interest not only among paint manufacturers but also among paint users and paint consumers.

It is probably not too much to assert that no pigment has increased more rapidly in use during recent years than has zinc oxide or as it is frequently called "zinc white." Several reasons have contributed to this result, the two most important being, first, the great hygienic value of the material, *i.e.*, the fact that it is quite non-poisonous, and secondly, its great durability in situations which are very destructive to other pigments, notably white lead. The last of these points is ably dealt with in this little volume by the author, Mr J. Cruickshank Smith, and he, as an expert paint technologist of wide experience, clearly shows, in an impartial manner, that zinc oxide possesses other excellent qualities when used in a paint either by itself or in combination with other pigments.

But something additional may be said as to the hygienic side of the question, because it must be admitted that when the health and even lives of

2046528

the workpeople, *i.e.*, those who make or apply the constituents of which a paint is made—when these are so directly concerned it behoves us to look very closely into the question, and this applies equally to the architect and engineer and to the property owner and tenant.

There is nothing in the present volume which can rightly be viewed as an attack on white lead. All sides of a somewhat difficult problem have been very carefully considered and fairly dealt with, but it must be admitted that lead poisoning is a very serious evil, and if proof of this were needed it would be forthcoming in the fact that this form of poisoning was scheduled as "an accident" under the Workmen's Compensation Act 1907, and also that the use of lead is restricted or even forbidden in several Continental countries, notably in France.

Dr Thomas Oliver, in a book recently published, entitled "Diseases of Occupation," shows by an extract from the Annual Report of the Chief Inspector of Factories for the year 1906 that there were in that year 632 cases of lead poisoning reported, while in 1901 the number was 863, in the previous year 1,058, and in 1899 no less than 1,358. In face of these figures it is impossible to ignore the gravity of the situation. And it must be remembered that these figures do not, as a rule, include cases which occur among painters, because to notify such cases is not obligatory. Dr Oliver says: "Painters are extremely liable to suffer from lead poisoning, especially if working in close and confined spaces. They become affected by inhaling dust during the sandpapering of surfaces, the slithe given off during the burning-off of old paint, also by absorption through the skin, especially if it is cracked. Freshly painted surfaces give off emanations which are harmful to many persons." And it is worthy of remark here that the peculiar smell of freshly applied paint which is so marked when white lead is used as a base is almost entirely absent when zinc oxide is used. These facts cannot be ignored, however earnest we may be in our desire to be quite impartial.

The chapter contributed by Dr Laurie gives a number of interesting facts arrived at by investigation and research conducted quite independently, so that both he and the author may be said to corroborate each other. Thus a good deal of light is thrown upon a pigment which, although well known, has awakened a greatly increased interest in its use, particularly as the base of paints. A few recipes from well authenticated sources are added, with the object of making the book more complete, and it is hoped that it may be found useful in many quarters

AUTHOR'S PREFACE

So many attempts have been made during recent years on the one hand to extol and on the other to decry oxide of zinc as a paint material that the ordinary reader, whose sympathies in the matter are probably neutral, has been in danger of exclaiming: " In a multitude of counsellors there is confusion."

The primary object of this short treatise is to marshal in fairly orderly sequence the points concerning oxide of zinc considered as a paint base which the experience of practical men connected with both paint making and paint using has proved to be matters of ascertained fact.

The subject matter has been so arranged as to meet the needs of those interested in the commercial aspect of the question. In other words, abstruse technicalities have been avoided, and in cases in which there is room for difference of opinion the author has endeavoured to avoid partiality on either side.

It must not be supposed that the contents of this little book exhaust the subject of oxide of zinc, still less that the very wide subject of zinc pigments and paints is fully dealt with.

The name of Dr Laurie is so well known in connection with the elucidation of some of the problems that pertain to drying oils, varnishes and pigments (not excluding oxide of zinc) that the inclusion in the present volume of a section by him dealing with the results of some of his observations has been deemed advantageous.

The formulæ and recipes contained in Chapter VI. have been extracted from the published articles of Mr W. G. Scott, and have been included at the desire of the Editor in order to furnish guides or types in the compounding of various paint mixtures which contain oxide of zinc as an essential ingredient.

J. Cruickshank Smith.

London, July 31st, 1909.

CONTENTS

INTRODUCTION BY THE EDITOR.

AUTHOR'S PREFACE.

CHAPTER I.

PAGE

The Growing Interest in Oxide of Zinc—Commercial Oxide of Zinc—Modes of Production—Variations in Quality—Properties which determine Value—Zinc White—Historical Note on Oxide of Zinc 13

CHAPTER II.

Notes on Grinding Oxide of Zinc—Oil used in Grinding Oxide of Zinc—Admixture of Oxide of Zinc with other Pigments 19

CHAPTER III.

Mixed Paints based on Oxide of Zinc—Maxims to be observed in using Oxide of Zinc Paints—Semi-thinned Paints—House-painters' or Decorative Paints as distinguished from Protective Paints 31

CHAPTER IV.

Advantages and Disadvantages of Oxide of Zinc Paints in House Painting—Technical and Industrial Applications of Oxide of Zinc—The Question of Driers for Oxide of Zinc Paints—Typical Mixings for Oxide of Zinc Paints—Durability of Oxide of Zinc Paints—Essential Points in a Protective Paint—Durability Figures of Oxide of Zinc and other Pigments—Oxide of Zinc Paints from the Legal, Hygienic and Social Standpoints 39

CHAPTER V.

The Drying of Oxide of Zinc Paints (by A. P. Laurie, M.A., D.Sc.) 50

CHAPTER VI.

Miscellaneous Uses of Oxide of Zinc, with Recipes (by W G. Scott) 65

Appendix—The Preparation and Mixing of Oxide of Zinc Paints to suit Various Conditions and Classes of Work 81

Index 109

CHAPTER I

NOTWITHSTANDING the very large increase from year to year during the last decade in the use of oxide of zinc as the base or chief constituent of various paints its merits are by no means so widely known by paint users and paint makers as they might be, although the interest evinced in connection with this important pigment is rapidly increasing. Even paint manufacturers admit that there are many problems concerning oxide of zinc which have not been satisfactorily solved, but on the other hand the same applies to nearly every pigment, not excluding white lead.

An attempt is made in the following paragraphs to record in a fair and unbiassed way such practical and technical information regarding oxide of zinc as may reasonably be considered to be authenticated, and matters are discussed which not only concern the paint manufacturer and the paint user, that is the professional painter and decorator, but also the property owner. With regard to the last class a remark falls to be made. The average owner of property—and the word "property" in this connection is intended to include buildings, plant, machinery, railway stock and ships—does not as a rule possess a technical knowledge of paints. Consequently, if his professional adviser, agent or contractor fails through ignorance or self-interest to advise him as to the merits or demerits of the materials he employs or proposes to employ for the purpose of protecting his property, the man who ultimately pays the bill, that is the property owner, suffers loss and may with justice complain that his interests are not being properly protected.

COMMERCIAL OXIDE OF ZINC

Without entering into debatable questions we may concede that oxide of zinc is particularly adapted for certain purposes in paint making, and the fundamental question arises, what is oxide of zinc ? To answer this query necessitates the admission that commercial oxide of zinc varies rather widely in chemical composition and physical properties, and on the nature and extent of such variation depends the value of a particular sample for a specific purpose. There are at present two processes of commercial importance for producing oxide of zinc.

1. The process in which metallic zinc (spelter), first obtained from the ore of the metal by a metallurgical or fire process, is melted and sublimed under suitable conditions, its vapour being then burned under strict control. The resulting oxide of the metal is collected and graded according to the fineness and lightness of its particles. It is evident that metallic impurities in the spelter are liable to be perpetuated in the oxide of zinc. Thus compounds of lead, bismuth, cadmium and arsenic may find their way in minute proportions into the oxide of zinc. The process just outlined, however, gives

rise to the purest and best oxide of zinc obtainable, provided that due precautions are taken to employ spelter as free as possible from the impurities named. Oxide of zinc made by this process may consist of 99.98 per cent. of chemically pure oxide of zinc (ZnO), and the best commercial grades used in paint making need not contain more than one half (.5) per cent. of impurity, and of this small proportion no part need consist of deleterious impurities.

2. The process in which a zinc ore is roasted under suitable conditions (without previous separation of the metallic zinc as in 1), the volatilised and oxidised metal being collected. Oxide of zinc made by this process is used in large quantities and is somewhat cheaper than the material produced by process 1.

As a rule the best brands of zinc oxide produced by process (2), such as those which come from America, are nearly as pure as those obtained by the sublimation process, and yield on analysis 99 per cent. and upwards of chemically pure oxide of zinc. It may be noted in passing that certain Continental factories in which the ore is roasted send out an oxide which contains a considerable proportion of impurity, notably lead compounds consisting chiefly of sulphate of lead. Two to five per cent. of such impurities are quite commonly met with in these Continental brands, while some of the lower grade American brands are even more contaminated. Hence it does not appear to be quite correct to assign to all samples of oxide of zinc made by the latter process all the properties commonly associated with the former class. There are many applications for which the more or less impure oxides of zinc are eminently suitable, but their marked difference from the purer oxides obtained by process (1) should be carefully noted, especially by the paint maker. The brand known as "red seal" is common to all manufacturers, and denotes a commercial grade of arbitrary composition and quality. Hence the "red seal" of one maker may and frequently does differ materially from the "red seal" of another maker.

To sum up, oxide of zinc varies in its chemical composition and in its value as a paint material. It therefore behoves buyers and users of the material to exercise careful discrimination in purchasing oxide of zinc, and to protect themselves by carefully drawn descriptions or specifications so worded as to suit the circumstances of each case.

The properties which may be regarded as determining the value of a sample of commercial dry oxide of zinc for the *ordinary purposes* of paint making are :—

1. Percentage of ZnO ; the nearer to 99.8 per cent. the better.

2. Absence of metallic impurities (in particular lead, bismuth and cadmium) liable to produce coloured compounds on exposure to sulphuretted hydrogen.

3. Specific Gravity ; the nearer to 5.6 the better.

4. Whiteness in comparison with a standard.

5. Ease with which the sample can be finely ground in oil, and the texture of the resulting mixture.

ZINC WHITE

Questions frequently arise as to the precise significance of the term "zinc white." Until about twenty-five years ago the expression was invariably regarded as synonomous with "oxide of zinc." About that time a new white pigment of entirely different character and composition was produced and marketed as "zinc white." At the present time in the paint trade "zinc white" is frequently understood to mean "oxide of zinc," but as two totally different pigments are sold under the description "zinc white" it is safer to employ the term "oxide of zinc" when that pigment is required.

HISTORICAL NOTE ON OXIDE OF ZINC

It was Courtois of Dijon who in 1781 brought oxide of zinc into prominence in a commercial sense, and three years later we find the material referred to in favourable terms in an English work dealing with artists' materials. The product of Courtois and others about that time was irregular in quality and more or less imperfect.

To Sorel must be accorded the credit of having first produced the substance by sublimation of the metal on a commercial scale. About 1834, while experimenting on the galvanising of metals, he noticed that the edges of his metal baths became encrusted with a white powder, which on analysis proved to be oxide of zinc. This set him on to devote his energy and scientific skill to the devising of improvements in the commercial production of the pigment.

In 1837 he took out his patent for galvanising iron, and his subsequent patents of 1840, 1841, and 1845, had all one aim, namely, to modify and perfect his apparatus and methods for the production of oxide of zinc. By the year 1841 he had erected furnaces at Grenelle.

Soon after this he became known to the Vieille Montagne Co., who were manufacturers of metallic zinc. They supplied the metal and received from Sorel the oxide in exchange.

Seeing the strides that the manufacture of oxide of zinc had taken, and the rapid and regular increase in its consumption, the Vieille Montagne Co. naturally desired to make it themselves, and with this object in view set themselves to study the whole question, succeeding in due course in erecting a retort furnace, for which they took out a patent. At the same moment Sorel protected his new crucible furnace. Since that time the Vieille Montagne Co. and the business successors of Sorel have pursued the manufacture of oxide of zinc independently.

CHAPTER II

NOTES ON GRINDING OXIDE OF ZINC

The grinding of dry oxide of zinc into the so-called " stiff paint " is a matter which concerns only the professional paint grinder, whose procedure will depend to a great extent on the purpose for which the oxide of zinc paint is to be used.

Oxide of zinc of the best quality used in paint making requires from 16 to 20 per cent. of oil (calculated on the weight of dry pigment) to grind it into " stiff paint." The margin between these figures is considerable, but it must be remembered that much depends on whether the stiff paint is to be used forthwith for ready mixed paint. If so, nothing is gained by grinding the stiff paint unduly stiff, and 20 per cent. of oil will be found a usual proportion. If, however, the paint is to be sold in the stiff or paste condition, a smaller proportion of oil will probably suffice, as a fairly crisp consistency is then preferred. The type of mixing and grinding machinery also affects the proportion of oil, and the nature and condition of the oil itself exerts an appreciable effect. The following are actual figures obtained in practice, the mixer being an edge-runner pan mill with positive drive, and the grinding mill being a 30 × 15 granite triple-roller mill.

Pigment.	% of oil to pigment.	Lbs. of oil per cwt. of pigment.	Oil.
1. Green Seal Oxide of zinc	20	22·4	Mixture of bleached refined linseed and H.B. pale boiled oil.
2. Red Seal do. ..	16	17·9	Bleached refined linseed.
3. American do. ..	14·4	16·1	Do.

1. Ground rather slack for mixed paint.
2. Ground stiff for sale in paste form.
3. Ground stiff for sale in paste form.

Efficient mixing is very important in the making of oxide of zinc paints, and the edge-runner type of mixer is probably the best. The floculent powdery nature of dry oxide of zinc of the best quality, and the peculiar physical properties possessed by the minute pigmentary particles of the material render it no easy matter to ensure thorough admixture of the pigment and the vehicle, but if every particle is not wetted with the vehicle in the mixer the grinding plant has to fulfill the purpose of a mixer as well as that of a grinder, and inefficient grinding is liable to result. Hence the grinding in the roller mill is simplified and expedited by careful attention to the mixing process beforehand.

Different brands of oxide of zinc vary considerably in the hardness and size of their particles, and the paint grinder who desires to master the peculiarities of the pigment under review cannot afford to neglect these points.

OIL USED IN GRINDING OXIDE OF ZINC

Side by side with the question of the proper selection of oxide of zinc for different classes and grades of paint comes that of the best vehicle to use in transforming the dry pigment into a paste. Much might be said on this subject and there is room for much divergence of opinion, but there are a few points on which most paint grinders are now agreed, and it may be well to recapitulate these here.

1. The vehicle should be as colourless as possible. The tinctorial power of oxide of zinc is relatively low, and consequently it is readily stained by a coloured medium. If the characteristic properties of oxide of zinc are to be retained in the paint, ordinary raw linseed oil is quite inadmissable as a vehicle by reason of its marked yellow colour, which readily stains the oxide of zinc. Refined linseed oil is therefore usually employed in grinding oxide of zinc. Most of the refined linseed oil used by paint grinders in Britain is made by the old acid refining process, which cannot be regarded as a scientifically perfect one. Linseed oil that has been refined by the sulphuric acid method cannot fail to be altered chemically and physically, one curious result being that a continual regeneration of free fatty acid is induced. Oil freed from mucilage and bleached by what is known as the " earth process " is better, and paint grinders who have carefully followed scientific progress in the oil industry are no

doubt familiar with the best process known at present for bleaching and refining linseed oil for paint making.*

On the Continent poppy oil has been used to no inconsiderable extent in grinding oxide of zinc, and so far as colour is concerned the oil leaves little to be desired. Poppy oil has, however, become scarce and expensive, and at the present time its use in place of linseed oil would increase the cost of the stiff paint about £3 per ton.

Some grinders prefer a vehicle with more viscosity than refined linseed oil, and consequently introduce into their grinding oil a proportion of thickened linseed oil (stand-oil) or pale boiled linseed oil. No general rule can be given as to the advisability of using such thickeners, as incidental circumstances must be taken into account. For example, if very efficient mixing and grinding machinery is employed and the grinder desires to turn out a rather stiff paste containing the minimum quantity of vehicle no particular purpose is served by using an excessively viscous vehicle. In other cases, however, the use of such a vehicle is attended with good results.

---

* Remarkable differences in colour and drying properties are observed in the three classes of linseed oil (Baltic, East Indian and South American) when they are treated with siccatives in order to produce "drying," "treated," or "siccative" oils for use in mixed paints, and paint manufacturers are recommended to investigate these points carefully before deciding on manufacturing formulæ. Unfortunately the authenticated knowledge at our disposal on these matters is limited at present, but some useful and original information is contained in a paper by Mr T. A. Davidson on "The Action of Driers on Linseed Oil" (see Proceedings of the Paint and Varnish Society, 1908–9, published in *The Decorator* November, 1908, No. 77, Vol. 7).

2. The question of drying must not be lost sight of in selecting a suitable vehicle. Somewhat extensive enquiries go to show that in France, Belgium and Germany, where zinc paints are extensively used by house painters, the question of the time taken by the paint to " dry " is not nearly so clamant as in Britain where paint manufacturers know to their cost that a paint which takes more than twelve hours to dry sufficiently for another coat to be laid on it, is liable to be absolutely and irrevocably condemned by the painter. It would not be correct to say that paints which take twenty-four hours to dry on the Continent and are looked on with favour there are for that reason suitable for use in Britain. It must be borne in mind that climatic conditions as well as economic and labour considerations vary immensely in different countries. Nevertheless, British paint users and property owners require to be instructed as to the real inwardness and mechanism of the drying of paint, because there is grave reason to suspect that the more the drying properties of paint are increased by artificial means, the greater do the risks become of rapid deterioration in the paint film and consequent damage to the surface which the paint is intended to protect.

Pale boiled linseed oil is used in the grinding of oxide of zinc paints by some grinders with the object of assisting the drying of the paint when it ultimately comes to be thinned for use, and when the stiff paint contains a considerable proportion of oil the procedure is to be recommended. There is still room for improvement in the manufacture of specially prepared grinding and siccative oils suitable for different classes of work, but the discussion of such matters is outside the scope of the present volume. It may be noted incidentally, however, that a very efficient and inexpensive drying oil can be prepared by treating well tanked linseed oil at a temperature of about 220° F. in a steam jacketed pan (which may be fitted with an air-blowing arrangement) with .25 per cent. of borate of manganese. The only real objection to oil so prepared is that it tends to darken in colour, a property which is associated with most of the manganese driers commonly used. The main point it is desired to bring out here is that the paint grinder who hopes for success in the region of zinc paints must bring his knowledge up to date in all matters relating to the ageing, bleaching, refining, thickening and boiling of linseed oil and also to the materials and methods used to increase the siccative properties of that standard vehicle.

3. The vehicle should be as neutral and as free from active chemical matter as possible.

Obviously the considerations outlined in (1) (2) and (3) may involve complications and sometimes apparent contradictions. Intelligent compromise is therefore the keynote of the procedure in grinding oxide of zinc, and for that matter all pigments.

ADMIXTURE OF OXIDE OF ZINC WITH OTHER PIGMENTS

The question of admixtures of pigments is one which the paint grinder cannot evade, but it is one which brings us into the midst of highly controversial matter. All readers of the technical paint literature of the last ten years are familiar with the somewhat threadbare arguments in favour of this or that pigment. Exaggeration and self interest are at the root of much of the wild talk about the " best paint," the " best pigment," and so on. Then the words " pure " and " genuine " are a fetish with some people, paint materials being frequently valued more for which they are supposed to contain than for what they are capable of doing.

Oxide of zinc is one of the standard paint pigments and for certain purposes cannot satisfactorily be superseded by any other pigment or combination of pigments, but the same is true of hydrated carbonate of lead and many other pigments in their commercial forms. One of the main distinctions between the scientific paint-maker and the rule-of-thumb paint-monger is the knowledge possessed by the former and lacking in the latter as to the best pigment or combination of pigments for use in different paints which are to be subjected to diverse conditions. Thus the keenest supporter of oxide of zinc will, if he be honest and intelligent, find frequent occasion to recommend white lead for some specific purpose, and the champion of so-called " pure paints " will not readily spurn the aid of barytes or gypsum or whiting or asbestine.

To deal in an exhaustive manner with this question of the blending of pigments would be to write a comprehensive treatise on paint making, and there is reason to suspect that all the technical and practical problems connected with the blending of pigments in paint have not yet been attacked in an effective way in Britain, although there are clear indications that the attention of the leading paint manufacturers is now being seriously directed to these matters. It may be predicted with reasonable certainty that as the line of demarcation between the craftsman painter and the expert paint manufacturer becomes more distinct (evidence of which is becoming more patent year by year) the scope for intelligent improvement in paint materials by scientifically trained manufacturers will increase.

The white pigments* which are capable of being mixed with what may be termed first grade oxide of zinc in paint are :

1. Cheaper grades of oxide of zinc of the kind referred to in page 15.
2. Sulphide zinc white.
3. White lead.
4. Barium sulphate (in the form either of natural barytes or of precipitated barium sulphate).
5. Hydrated calcium sulphate (gypsum or terra alba).
6. Finely powdered asbestos (asbestine).

With the possible exception of (1) and (5) all the above are capable of admixture with oxide of zinc for the purpose of modifying the properties of the resulting paint in a specific manner.

---

* A very valuable protective mixture is also provided by red lead in conjunction with oxide of zinc. Here the presence of a little lead in the oxide of zinc itself can hardly be regarded as a serious objection. Some galvanized iron roofing in Wigan was treated by the author with a paint containing red lead, American oxide of zinc, raw linseed oil, a little copal varnish, and very little turps. After three years' exposure in an atmosphere heavily charged with active chemical matter the surface was hardly damaged, and the metal beneath showed no signs of corrosion except in a few isolated patches where the paint flaked off bodily.

It is a mistake to suppose that the use of oxide of zinc or indeed of any pigment is confined to the preparation of ordinary decorative paints for house painters. The manufacture of antifouling and ship's bottom compositions, protective paints for iron and steel, enamels and enamel paints, fireproof paints, tempera paints, etc., accounts for a large and ever increasing consumption of oxide of zinc, and it is in such specialised products that the chief opportunities for the scientific blending of pigments occur. A sharp distinction is to be made between pigments introduced into paint merely as cheapeners or adulterants (sometimes euphemistically referred to as " fillers " or " extenders ") and pigments which, irrespective of their cost price, impart some valuable property to the paint.

Reverting, therefore, to the list of pigments just given, we may take it as unlikely that (1) or (5) would be introduced into paint except for the purpose of cheapening it. Both sulphide zinc white and terra alla are recognised as legitimate materials for cheapening oxide of zinc paints, and as there are many purposes for which a paint cheaper than the best is required by the paint-buying public the use of these two pigments in conjunction with oxide of zinc may be and frequently is not only defensible but necessary. Indeed so far as sulphide zinc white is concerned, certain advantageous properties may be communicated to the paint by its presence. But if such pigments as sulphide zinc white and terra alla are used in such proportions as to render of no practical effect the specific properties of oxide of zinc, then it becomes a fraud on the public to offer such adulterated paints as oxide of zinc paints. On the other hand, (2), (3), (4) and (6) may be mixed with oxide of zinc for the purpose of producing a paint whose properties are superior in certain particulars to those of paints based on any one pigment. The blending of oxide of zinc with white lead and of both these pigments with barium sulphate is a branch of paint technology which has not been studied with any degree of thoroughness in this country. The behaviour of pigments when intimately mixed with vehicles adapted and adjusted to suit the peculiar physical properties of the pigments in question is a matter in which research is urgently wanted, and the practical results will probably repay those who undertake it.

A good deal of nonsense is heard about the "settling down" of certain pigments in mixed paint. It is frequently stated that barium sulphate "settles down" when associated with oxide of zinc in a mixed paint, and the reason is glibly stated to be that barium sulphate is so much heavier than oxide of zinc. As a matter of fact, the reverse is the case. The specific gravity of oxide of zinc of average quality varies from 5.0 to 5.6, whereas the heaviest native barytes never possesses a specific gravity so high as 5.0, and that of precipitated barium sulphate is considerably less. The reason of the differential settlement that without doubt frequently takes place when mixtures of pigments are suspended in a fluid vehicle is that the particles are not all of the same size or even approximately so. In other words the paint is imperfectly ground, and it is a fact which has been proved by observation and experiment that the rate of settling of very small solid particles does not bear any definite relation to their specific gravity but is a function of the size of the particles. Consequently the plan adopted by some paint grinder of mixing a " light " pigment with a " heavy " one in order to " keep up " the latter is a crude and unscientific one unless the question of the size of the particles is taken into consideration.

This is not the place to enter into a discussion of the controversy as to the respective merits of white lead and oxide of zinc. The attitude which is most consonant both with scientific truth and commonsense is that each of the two pigments possesses merits and demerits, both have their value for specific purposes, and each should be used with due regard to its inherent limitations. There has undoubtedly been considerable misrepresentation and ignorance as to the true value of oxide of zinc, and for details on this subject the reader is directed to the author's paper, " Oxide of Zinc," read before the Royal Institute of British Decorators in March, 1904 (vide *The Decorator*, Vol. III., page 305).

Powdered asbestos (asbestine) is a material which has recently found considerable use in conjunction with oxide of zinc. The technology of the material is less well known to paint manufacturers than it might be, and for interesting details as to its application, composition, etc., the reader is referred to the " Journal of the Society for Chemical Industry," Vol. I., p. 355 and Vol. II., p. 351 ; and

Jahresbericht uber die Fortschritte der Chemie, XXXIII., p. 1463, and XXXVI., p. 1892, as well as to recent publications on the technology of paints in America.

CHAPTER III

MIXED PAINTS BASED ON OXIDE OF ZINC

The term "mixed paints" may be taken to include all preparations or compositions of the nature of paint, whether employed as decorative or as protective agents, provided they are in a form ready for application. It therefore embraces not only ordinary house-painters' paints, but also enamels, enamel paints and a great variety of protective paints used for specific purposes. One of the commonest mistakes made by the house painter is to imagine that in rejecting modern oxide of zinc mixed paints he is rejecting something which has never been heard of before in the making of paints. As a matter of fact the house painter, and particularly the British house-painter, is more behindhand in a knowledge of the materials of his craft than most of his brethren in other departments of the building and allied trades. It is equally a mistake, however, on the part of manufacturers to imagine that oxide of zinc paints can or will be used in preference to other white pigments for every conceivable purpose in painting.

A distinction must always be drawn between paints intended essentially for the purpose of decoration and those whose main object is protection.

Not only is the composition of a protective paint different from that of a paint whose main purpose is decoration but the mode of application varies. An eminent engineer who is concerned largely in superintending the application of protective paints and preparations to structural iron work has expressed his preference for unskilled labourers over skilled painter craftsmen in applying protective paints for the reason that the craftsman painter with his inborn desire to secure a good piece of handiwork is much more prone than an unskilled man to tamper with the paint (in the way of adding turpentine, etc) in order to make it conform to his ideas of what paint should be and how it should work. Certain paints used to protect ironwork must be " rubbed in " in order to obtain the full value of their protective properties. Now the professional painter does not rub his paint in ; he " lays it off," and herein is the crux of the whole matter.

Oxide of zinc paints among others have suffered in reputation for the above mentioned reason, and here also is to be found the cause of the extraordinary divergence of opinion which is met with as to the efficiency of oxide of zinc paint as compared with some other paint when applied under different conditions by different operators. The discrepancy between laboratory or testing-room tests and service tests on the large scale can often be explained in the same way.

It is outside the scope of this work to discuss either the composition of *protective paints* based on oxide of zinc, or the best mode of handling them. We may, however, briefly consider the main points that arise in the handling of ordinary oxide of zinc paints as used by the house painter and decorator. The following maxims may be accepted as the result of experience :—

1. In order to obtain the full intrinsic value of oxide of zinc it is necessary that the painting should be carried out as a qualified craftsman would do it, namely, with two, three or more coats. Oxide of zinc does not assist the man who " scamps " his work or who attempts to do with one coat what should be done with three.

2. Oxide of zinc paints should be applied in as thin coats as possible, but the paint must not be mixed thin. On the contrary it should be mixed as round as possible. Thus the great spreading power of oxide of zinc is taken full advantage of, repeated experiments having proved that three coats of oxide of zinc paint properly applied obscure the surface equally as well as three coats of genuine white lead paint.

3. The vehicle used in oxide of zinc paints should consist as largely as possible of suitably prepared linseed oil, and should contain the minimum quantity of volatile vehicle (turps).

4. The peculiar chemical and physical properties of oxide of zinc render the use of a preparation of hard resin (in the form of varnish) advantageous in oxide of zinc paints intended for outside use.

5. In the case of oxide of zinc " flatting " paints it must not be forgotten that the proportion of oil in ground oxide of zinc is very much greater than the proportion of oil in ground white lead. Con-

sequently if a perfect "flatting" is required the excess of oil must be removed by breaking up the ground oxide of zinc with a proportion of turpentine, allowing the mixed mass to stand overnight and skimming off the mixture of oil and turps that rises to the surface. If then the pasty residue is mixed with turpentine and a suitable binding material a perfect "flatting" is obtained.

Oxide of zinc paints for decorative purposes come before the painter and decorator in two distinct forms :—

1. Oxide of zinc ground with about 20 per cent. of refined linseed oil, and forming the stiff paste known as "oxide of zinc ground in oil."

2. Paints containing oxide of zinc as their base, and prepared for the brush by the addition of liquid vehicle, driers, etc.

There is no doubt that some part at any rate of the prejudice which the craftsman painter evinces against oxide of zinc paints is due to the unsatisfactory form in which these materials are frequently offered to him. It cannot be alleged that either of the two above mentioned forms are perfectly satisfactory from the painter's point of view. The objection to (1) is that it is difficult for a painter *using the ordinary materials which he uses in connection with the mixing of white lead paints* to mix paste oxide of zinc so as to produce a paint which is satisfactory in use to the craftsman who applies it, or which compares satisfactorily with white lead paint as regards durability. The reason is of course (and this is a point that most painters are now familiar with from their own experience) that the vehicles and driers which should be used in the thinning and mixing of oxide of zinc are essentially different from those which are commonly used in the thinning and mixing of paste white lead, and as these special ingredients are not yet as a rule currently bought and sold in the decorative paint trade, the painter who is directed either by his architect or by his client to use oxide of zinc paint and who purchases it in paste form is liable to be seriously handicapped from the outset.

The objection which the craftsman painter has to mixed paints coming under category (2) is that they are not susceptible to modification and alteration during the progress of the work. In view of the fact that every surface which has to be painted (whether that surface is unpainted or has already received one, two, three or more coats of paint) must be dealt with on its own merits, and since the paint which is to be applied to it must be modified accordingly it is obviously impossible to effect any satisfactory modification in the composition or consistency of a paint which is already thinned to the maximum extent.

Considerations such as these have resulted in the suggestion that a preferable method, both from the scientific and from the practical standpoint, is to provide the craftsman painter with his oxide of zinc paint in a semi-thinned form, which permits him to make those final adjustments and alterations as to consistency, relative proportion of oil and turps, quantity of drying material, etc., which his experience tells him are necessary for the proper carrying out of the particular work which he has in hand. At the same time the paint manufacturer from his expert knowledge of the special properties of the pigment base in the paint is able to introduce into the material such essential constituents other than pigment as he considers will give the best results when the paint comes to be finally thinned to working consistency by the painter.

There has for long been a conflict between the paint manufacturer and the craftsman painter in connection with the materials used by the latter. On the one hand the paint manufacturer alleges that it is his particular province to make the paint, and that the painter's province is to apply it. On the other hand the painter asserts with equal vehemence that no paint manufacturer is able to make paint which is adapted to the numerous conditions which the painter is called upon to face in his daily work.

The advantage of the method outlined above is that it is in the nature of a compromise whereby both the special knowledge of the manufacturer and the experienced practical skill of the painter are called into requisition, and it may be suggested with a fair degree of assurance that the continued and increased popularity of oxide of zinc paints will depend to a great extent on the ability of the paint manufacturer to place on the market suitable semi-thinned paints of the nature indicated.

It must not be imagined that the sole use of oxide of zinc as a paint base in decorative paints is, or is likely to be, limited to its use as the sole pigmentary base in such materials. There is great scope for the careful and scientific blending of oxide of zinc with other pigments in decorative paints. Thus, a mixture of oxide of zinc and white lead is to be recommended for certain purposes. Again, a mixture of white lead, barium sulphate and oxide of zinc has been shown to resist certain destructive influences more satisfactorily than any one of the three pigments used along. Again, the nature of the vehicle is capable of wide modification. Treated oils, varnishes and other special vehicles should be used as occasion demands. The use of oxide of zinc in conjunction with red lead has already been referred to, as also have the relative advantages of different grades of oxide of zinc itself.

Questions are sometimes asked by practical painters as to the best mode of priming work that has to be finally finished with oxide of zinc. The oxide of zinc " whole-hogger " (if we may borrow a term from current economic politics) will of course say that oxide of zinc paint is the best primer as well as the best material for finishing painting work. This view is, however, open to question, at any rate in many cases.

As we are now dealing mainly with the applications of oxide of zinc to decorative work, the question of the treatment of iron and steel is not prominently before us, but so far as woodwork is concerned it has yet to be proved that as a priming material oxide of zinc is preferable to white lead. With the hygienic point of view we are not for the moment concerned. It is a rule in properly conducted painting work that no two successive coats of paint should possess precisely the same consistency or be identical as regards composition of vehicle. That is to say, if work is to be finished in three coats of oxide of zinc paint, then each of the three coats should vary as regards the relative proportions of pigment, oil and turps. For example, if work is to be finished flat then each successive coat should contain more turpentine and less oil than the preceding one. If the finishing coat is to be glossy then each successive coat should contain more oil and less turpentine than the one before it, the proportion of pigment being varied according to the particular circumstances of the case. It is now the custom on the Continent, where oxide of zinc has for a considerable time been used in preference to other pigments for certain classes of work, to lay down precise rules as to the composition of the various coats.

For particulars and suggestions as to the composition of the various coats of oxide of zinc paint the reader may consult the author's paper on "The Preparation and Mixing of Oxide of Zinc Paints to Suit various Conditions and Classes of Work" (*The Decorator*, Vol. V., 1906, pp. 40 and 66).*

It is worthy of remark that during the last two years H.M. Office of Works has issued in connection with painting contracts under its control more or less definite specifications as to the composition of the zinc paints used therein. These specifications are to be welcomed as marking a distinct advance in the method of purchasing paint for public works.

[* This paper has been incorporated in the present work in the form of an appendix.—ED.]

CHAPTER IV

THE ADVANTAGES AND DISADVANTAGES OF OXIDE OF ZINC PAINTS IN HOUSE PAINTING

ALLUSION has already been made to several of the advantages and disadvantages of oxide of zinc as a paint pigment. Not least among its advantages are of course its marked hygienic and sanitary properties as compared with its chief rival white lead. There must also be considered the great permanence of oxide of zinc in respect of colour. When of good quality and properly mixed oxide of zinc undoubtedly provides a paint base which so far as white pigments are concerned is far in advance of any other in respect of its immunity from discolouration through outside agencies.

On the other hand, a disadvantage of many ready mixed oxide of zinc paints is their comparatively low opacity, which necessitates several coats being applied before a coloured surface can be obscured. It might be remarked that this disadvantage is not one which the painter craftsman ought to object to inasmuch as the burden of his lamentation nowadays usually is that attempts are constantly being made to finish work in one coat which in the flowery days of his youth were invariably executed in three coats.

Another and perhaps a more serious objection at the present time is the absence of intelligent understanding on the part both of paint manufacturers and paint users as to the manner in which oxide of zinc ought to be mixed and used as a paint. There is reason to believe that this state of things is rapidly passing away, and there are on the market at the present time several oxide of zinc paints which leave little to be desired on the score of efficiency and economy.

One of the most serious objections, however, advanced against oxide of zinc paint by the practical painter is the difficulty of getting these materials to dry within a reasonable period, and it must be admitted that considerable trouble has arisen on this score when the painter has used oxide of zinc for the first time. Undoubtedly if the painter is not provided with specially prepared driers and if he is left to flounder by himself in the matter of zinc driers he is liable to experience trouble. Fortunately, the difficulties connected with the drying of zinc paints have been attacked and largely surmounted, and in a later section this subject is referred to at greater length.

TECHNICAL AND INDUSTRIAL APPLICATIONS OF OXIDE OF ZINC

Several of these have already been enumerated. A very well known instance of the use of oxide of zinc in preference to white lead is in connection with paints which have to withstand the action of salt water—*marine paints* as they are usually called. Here we have a case in which no white pigment with any pretentions to opacity can at the present time supersede oxide of zinc of good quality.

We have already referred to anti-fouling compositions as being based largely on oxide of zinc. Oxide of zinc possesses the property of combining readily with the acid bodies in what are frequently referred to as "gum resins." Oxide of zinc is therefore pre-eminently adapted for being ground in suitable varnishes or varnish-like preparations. This process forms the basis of several well known ships'-bottom compositions and materials of a similar nature. For fire-resisting paints and enamels used in electric works and the like oxide of zinc justly enjoys a high reputation, while the tens of thousands of gallons of white enamel which are annually manufactured in Britain and elsewhere afford sufficient evidence of the enormous consumption of oxide of zinc in that direction.

THE QUESTION OF DRIERS FOR OXIDE OF ZINC PAINTS

Here we touch on one of the crucial questions in connection with the manufacture and use of oxide of zinc paints. If we assume that a pure oxide of zinc paint is in question and that the pigment in the same has been properly selected and has been ground in a suitable medium, if we suppose further that the resulting paste has been thinned for use with well selected vehicles and that a proper consistency has been arrived at, then the success or failure of the paint will probably depend on the rate and mode of drying.

It is necessary for the painter to understand in the first place that the practice he follows in the case of white lead paints is not a safe guide in the case of oxide of zinc paints, and he might with advantage reason the matter out *ab initio*.

Oxide of zinc is not a drier ; it has no siccative action on linseed oil. Herein it differs from white lead. Consequently if it is necessary that the paint should dry in a shorter period than would have to elapse for the spontaneous drying of the film through the oxidising action of the atmosphere some artificial stimulus must be applied, and the nature and extent of this stimulus constitutes the whole problem in the drying of oxide of zinc paints. As Dr A. P. Laurie, who has made a special study of this matter, contributes a chapter on the drying of oxide of zinc paints the matter will not be elaborately dealt with here, but the following are a few observations which have been borne out in practical experience :—

1. Solid driers, or as they are commonly called patent or paste driers, are not as a rule suitable for use in oxide of zinc paints.

2. The best results in the drying of such paints are probably obtained by a combination of specially prepared drying oil introduced during the mixing

and grinding of the stiff paint and a liquid drier* added during mixing.

3. The composition of the liquid drier should approximate to that of a specially prepared terebine, that is to say, it should contain a suitable drying agent associated with volatile solvent and hard resin. Probably linoleate of manganese furnishes the best drying agent, all things being taken into consideration.

4. If it is not necessary that lead compounds should be rigorously excluded from the ingredients (other than pigment) of the mixed paints the problem of providing a suitable drying agent is much simplified.

If a painter desires to mix oxide of zinc in oil with the ordinary thinners which he has been accustomed to use with white lead, the following proportions will serve as a guide. They must be accepted as approximate only, and the painter may have to vary the mixing according to local conditions, nature of the surface, time of year, etc. :

(a) Exterior Work, Finishing Coat—

Oxide of Zinc in Oil..............	56 lb.
Linseed Oil.......................	1 gallon, 3 pints.
Turps	3 pints.
Outside Mixing Varnish	1 pint.
Liquid Zinc Driers	½ pint.

---

* The use of Chinese wood oil (Tung oil) in this connection has been suggested, and has even been adopted by several manufacturers who employ scientific direction in their work and practice. Liquid or oil driers containing a proportion of this oil may be expected to furnish the key to several practical difficulties hitherto met with in the drying of oxide of zinc paints.

(b) Interior Work, Finishing Coat—Glossy—

Oxide of Zinc in Oil	56 lb.
Linseed Oil	1½ gallons.
Turps	½ gallon.
Mixing Varnish	1 pint.
Liquid Zinc Driers	¾ pint.

(c) Interior Work, or Preparation for Enamel—

Oxide of Zinc in Oil	56 lb.
Linseed Oil	¼ gallon.
Turps	1½ gallons.
Flat Mixing Varnish or Gold Size	½ pint.
Liquid Zinc Driers	½ pint.

DURABILITY OF OXIDE OF ZINC PAINTS

There are several methods of estimating the economic value of paints. Perhaps the most fallacious of all is based on the prime cost of the paint itself. At first sight it might appear curious that the prime cost of paint should effect in so small a degree as is here suggested the ultimate economic value of the material, but a little consideration will show how reasonable this is. It should be borne in mind that the cost of painting work does not wholly or even approximately consist in the price of the materials. On an average four-fifths of the cost of finished painting work is due to labour. Consequently an increase in the prime cost of the materials is much reduced when spread over the total expenses of a painting contract.

Another vital consideration is the length of time during which the work may be expected to last. For example, the paint used on a certain piece of work may have cost 40/-. The work stands for five years before repainting is necessary. At the end of five years, therefore, the cost of paint materials on the work in question is 40/-. On another similar piece of work of equal dimensions painted at the same time the paint cost 30/-. After three years' exposure it is found that the cheaper paint has perished, and consequently the work has to be repainted. The cost per annum for paint in the first case is 8s., whereas in the second case it is 10/-. Therefore the dearer paint is the cheaper !

In considering the economic value of oxide of zinc considered as a base for protective paints such considerations as these must always be taken into account, and the greatest caution should be exercised in making or accepting statements as to the relative cost of different paint materials in the absence of precise information as to what " cost " means. The question of durability in protective paints is a fundamental one and is complicated with all sorts of side issues, so much so that data as to the relative durability of different paints applied to various surfaces under different conditions are frequently hopelessly involved and contradictory. With regard to oxide of zinc this much may be said with confidence, that when it is properly manufactured into a paint and is applied with due regard to its special properties it constitutes a paint base which can well take its stand among the most economical of the true protective paints. Whether or not oxide of zinc paint will be a better protective paint than, let us say, oxide of iron paint or graphite paint on a particular surface will depend on a variety of circumstances.

It may be well to recapitulate what the essential points in a protective paint are.

1. The pigments and other ingredients of the paint should be as inert as possible towards each other. In other words, internal chemical changes are to be avoided.

2. The chemical composition of the paint should be such as to render decomposition through outside causes as unlikely as possible.

3. The physical properties of the dry paint film should be such as to render cracking, scaling, and other mechanical faults as unlikely as possible.

4. The composition, physical properties and mode of application should be such as to render the penetration of moisture through the paint film as difficult as possible.

Now oxide of zinc paints when properly prepared and applied are intrinsically well suited to conform to these conditions. It is therefore quite correct to refer to oxide of zinc paints as protective paints if we assume that they have been scientifically and properly prepared. In the following table an attempt has been made to provide a basis for estimating the probable economic value of several typical protective paints, including oxide of zinc, such essential conditions as prime cost of materials, covering or spreading power and probable durability being taken into account. It is well to state, however, that the figures here given must be accepted with due reserve, because conditions vary so much on different pieces of work that it is extremely difficult to forecast with any degree of certainty what the life of the paint film will be in actual service where the conditions are to a certain extent unknown. The figures given in the table are based on actual measurements so far as spreading powers are concerned. Costs both of materials and labour are on the basis of actual market value, while the durability figures are largely the result of observation extending over a number of years.

TABLE SHOWING COMPARATIVE DURABILITY FIGURES OF VARIOUS PROTECTIVE PAINTS.

	A Spreading Capacity in sq. yds. per cwt.	B Price per cwt. in shillings.	C Materials cost in shillings per 100 sq. yds.	D Estimated number of times painted in 20 years.	E Materials cost in shillings per 100 sq. yds. for 20 years	F Labour costs in shillings per 100 sq. yds. for 20 years.	G Estimated total cost of painting & renewals (in shillings) per coat per 100 sq. yds for 20 years.
I. Oxide of Zinc ..	870	46·0	5·29	4	21·16	66·66	87·82
II. Red Lead	424	28·0	6·60	4	26·40	66·66	93·06
III. White Lead..	614	28·0	4·56	5	22·80	83·33	106·13
*IV. White Lead	806	32·0	3·97	6	23·82	100·00	123·82
V. Oxide of Iron ..	1080	24·0	2·22	7	15·54	116·66	132·20

*Contains more turps than III.

GENERAL FORMULA FOR CALCULATING THE ESTIMATED DURABILITY—(G) OF ANY PAINT.

$$G = \frac{100 \times p \times t.}{C} + \frac{25 \times l \times t.}{3}$$

Where p = price of paint in shillings per cwt.
t = Estimated number of times painted in 20 years.
c = Spreading capacity of paint in sq. yds. per cwt. per coat.
l = Cost of labour in pence per sq. yd. per coat.

OXIDE OF ZINC PAINTS FROM THE LEGAL, HYGIENIC AND SOCIAL STANDPOINTS

The tendency of modern legislation is to protect the health and to ameliorate the social surroundings of the workers. Nothing is more noticeable than the protection now afforded by the law to workers and to all whose activities are useful to the community. The Factory Acts, the Workmen's Compensation Acts and similar measures afford ample proof of this. Argue as one may about the comparative freedom from danger of those making or handling lead paints, the fact remains that year by year several hundred authentic cases of lead posioning come to light, and there is ample reason to surmise that a further large number of cases of plumbism occur which are not officially reported. Cases of lead poisoning therefore cannot be looked upon as rare, and although it is probably quite true that such accidents are more or less preventable by strict cleanliness and the like we must accept facts as they are. Statistics have shown that many cases of lead poisoning are traceable to occupations in which lead compounds in the form of dust are breathed into the system. Thus in coachbuilding, an occupation in which much sandpapering and rubbing down of lead painted surfaces are carried on, cases of lead poisoning are by no means infrequent.

Undoubtedly from the hygienic and sanitary standpoint the total abolition of white lead paints would be attended with good results. At the same time this might be regarded as an extreme and arbitrary step to take, and the present tendency, in this country at least, appears to be to reduce as far as possible the unguarded use of lead compounds, and at the same time to educate those who handle such materials in the elementary notions of hygiene and personal cleanliness.

From the legal standpoint some serious considerations arise in connection with the use of poisonous pigments. The most recent Workmen's Compensation Act makes white lead poisoning, if incurred in the course of a workman's duties, an accident within the meaning of the Act, and consequently his employer can be compelled to compensate him. The Board of Trade regulations as to white lead factories are at the present time very severe, and in order to avoid the rigorous enactments in connection with such works several paint manufacturers have given up grinding white lead, and in some cases have refused to employ lead compounds altogether. This all goes to show that the handling of lead compounds is recognised as involving certain risks, and the practical painter is one of the few people who have not hitherto taken any serious notice of the risks to which they voluntarily expose themselves. There is little doubt that when the question of the use and application of zinc paints becomes better understood hygienic consideration will count for more with those who make use of or enjoy the use of paints.

CHAPTER V

THE DRYING OF OXIDE OF ZINC PAINTS

By A. P. Laurie, M.A., D.Sc.

Owing to the fact that house painters and decorators have through so many generations been accustomed to the properties of white lead, while the properties of oxide of zinc are comparatively unknown, there are naturally many prejudices against the newer pigment. Each pigment necessarily requires to be introduced and used in the way best suited to its peculiar properties in order to bring out the best results, and the pigment which has been used most widely and for the longest time is naturally better known. The use of oxide of zinc in place of white lead is, however, deserving of every encouragement on the grounds of health alone. The deadly properties of white lead and the serious effects it produces both on those who make and those who use it are too well known to need repetition here, and are nevertheless probably more extensive than is suspected. Actual cases of definite lead poisoning find their way to the hospital and are entered in statistics, but the number of cases of lowered vitality and injured health are not so reported. It is therefore for the benefit of all that so poisonous a material should as largely as possible be replaced by the harmless substitute. It is only necessary to refer to the drastic action taken by the French Government to make all realise how serious a matter the use of white lead in large quantities is. The French, with their clear intellects, have not hesitated to decide between doubtful practical advantages on the one side and the health of a large section of the workers on the other. But the prejudice against oxide of zinc exists, and it is only by careful experiment and demonstration of its properties that these prejudices can be removed. One of the commonest of those is the idea that oxide of zinc is a slow and bad drier, and therefore unsuited for work which has to be finished quickly or for use outside in damp cold weather. In order to meet this criticism we must consider shortly what we mean by the " drying " of linseed oil. Linseed oil belongs to a group of vegetable oils, including poppy oil, nut oil and Chinese wood oil, which have the property of absorbing oxygen from the air, and being by this means converted into transparent elastic films which we call the dry oil. In many ways the use of the term "drying" is unfortunate as it conveys a wrong impression. Drying in the ordinary sense means loss of water by evaporation, or we might talk of the drying of a spirit varnish, the alcohol or turpentine used as a solvent evaporating and leaving the dissolved resin behind. But the " drying " of linseed oil is essentially different, the oil itself absorbs oxygen and changes into a new substance. Drying in the ordinary sense is accompanied by a loss of weight, but the " drying " of linseed oil is accompanied by a gain of weight.

Now the rate at which this drying or oxidation takes place depends on the nature of the oil itself, and the treatment to which it has been subjected before the drying process. If, for instance, we compare samples of poppy, linseed and Chinese wood oil, we shall find the poppy oil a slower drier than the linseed oil, and it is possible by proper preparation to get a Chinese wood oil that will dry when rubbed out on a glass plate in from thirty to forty minutes. Linseed oil in the raw state takes some days to dry, but the drying process can be hastened, as has been stated above, either by treating the oil in certain ways beforehand or during the drying process.

If, for instance, we take linseed oil and heat it either with compounds of lead, such as sugar of lead, red lead, or white lead, some of the lead dissolves in the oil, and we obtain what we know as a drying oil, which will, when exposed to air, dry much more quickly than the raw oil. Or if, on the other hand, we mix with our raw oil and pigment small quantities of these lead compounds as " driers," the " drying " of the oil is much hastened.

Compounds of lead are not the only substances which act in this way. The compounds of the metal manganese have a similar action, and if the oil is heated with peroxide, borate or resinate of manganese, or these compounds introduced into it in a dissolved state, we obtain the drying oils which are known as " manganese oils." But we can if we like just as in the case given above, introduce the manganese compounds as " driers " in place of the lead compounds.

Now it is evident from the above statements that a pigment may be in itself a "drier." For instance, umber contains manganese compounds, and acts consequently as a powerful drier. If, let us say, raw linseed oil, is ground with umber and red oxide respectively, and the two paints painted out side by side, the umber will dry long before the red oxide. But if suitable driers are added to the red oxide it can be made to dry as fast as, or faster than, the umber.

It is evident from what has been stated above that white lead is in itself a drier, and consequently if we ground a sample of white lead, and a sample of zinc oxide respectively, in linseed oil, and painted them side by side, the white lead sample would be dry long before the zinc oxide sample.

If, however, we add the most suitable drier to zinc oxide we can easily make it dry as fast as, or faster than, the white lead.

It is sometimes recommended that oxide of zinc be ground with a manganese drying oil instead of raw oil in order to hasten the drying of the paint. There is, however, no necessity for this. If, in the first instance, we compare zinc oxide ground in and thinned with manganese oil and zinc oxide ground in raw oil, and merely thinned with manganese oil, we shall find that the rate of drying is about the same, so that there is no need to grind the zinc oxide in manganese oil. Moreover, if a suitable drier is used, there is no need for ordinary inside work to use manganese oil at all, though for outside work in damp, rainy weather it is as well to thin with manganese oil, as well as add a suitable drier.

The rate of drying of zinc oxide ground in raw oil and thinned with manganese oil and turps when different driers are added is very well illustrated by the following experiments.

In each case the paint was rubbed out thinly on a thinly varnished wood panel kept in a moderately warm room.

White lead mixed with manganese oil and turpentine, but with no other drier, took twenty hours to dry, while zinc oxide ground in raw oil and mixed with manganese oil and turpentine, took forty-six hours to dry, thus illustrating the drying action of the white lead upon the oil.

But the addition to this zinc oxide mixture of about 1 per cent. of manganese borate, or manganese resinate, or manganese linoliate, caused the zinc white to dry in eight hours.

It is evident then from these experiments that the slow rate of drying of zinc white alone can be easily more than overcome by the addition of a little of a suitable drier.

This leads us to another question, and that is the amount of drier which needs to be added to a paint to produce the full effect of which it is capable. This is a much smaller quantity than is usually supposed, as is clearly shown by the following experiments, which were once originally published in *The Decorator.*

The same lot of zinc oxide, ground in raw oil, and thinned with manganese oil and turpentine, was divided into portions, and the following quantities of manganese borate and manganese resinate respectively ground into the paint on a muller, and each sample rubbed out and left to dry.

Percentage of Manganese Resinate to total paint.	Time of Drying.
·1%	21 hours.
·25%	14 hours.
·5%	8 hours.
2·0%	7 hours.

Borate of Manganese.	Time of drying.
·2%	18 hours.
·5%	12 hours.
1%	11 hours.
2%	9 hours.

Time of drying of the zinc oxide as prepared, but without the driers, forty-six hours.

It is evident from the figures that any quantity of manganese resinate over ·5 per cent., or five parts in one thousand, is simply being wasted. The manganese borate is, however, not so powerful a drier, and consequently may be added with advantage up to 1 per cent., or ten parts in one thousand. For indoor work there is no necessity to add manganese oil at all, ·2 per cent. to ·5 per cent. of manganese resinate and raw oil and turpentine will produce a satisfactory result. There is another advantage to be gained, however, by the use of manganese driers for zinc paint. One of the most useful properties of zinc oxide is that it keeps its colour in impure air, while white lead rapidly darkens. Now it is obvious that if we use a lead drier, such as ordinary patent drier, we shall largely destroy this advantageous property, the presence of a little patent drier or a drying oil prepared with a lead instead of a manganese compound being quite sufficient to cause the zinc white to darken in impure air.

Zinc oxide itself usually contains traces of lead, but these are in good samples so minute that they cannot produce a perceptible change of tint in the ground paint, although a slight colouration is is observable on mixing the dry pigment with water and exposing to sulphurated hydrogen. It is therefore highly probable that when complaints have been submitted that oxide of zinc has not kept its colour properly, it is due to the presence of driers containing lead, the trace of lead in good zinc white being quite insufficient to produce this effect as has been shown by careful tests.

It is therefore evident that patent driers should not on any account be used for oxide of zinc, but should be replaced by manganese resinate or borate.

This is best prepared for use by grinding it with about ten times its weight of zinc oxide and oil into a stiff paste. This can then be used by the house painter as a substitute for the patent drier he is accustomed to, and can be safely added by him in about the quantity he usually adds of patent drier.

If the grinders of zinc oxide would put such a drier on the market, there should be no more complaints of zinc oxide drying too slowly. Wood can be successfully painted in cold, misty weather and rain outside with zinc white ground in raw oil and thinned with manganese oil, turpentine, and this drier.

There is also an impression that zinc oxide does not "cover" so well as lead white. This is due to the fact that the pigment is not nearly so dense, and in grinding requires much more oil than lead. It is therefore thinner when painted on the surface, and if used in the same way as white lead, more coats are required, but it will be found that weight for weight, zinc white covers as well, or better than white lead, if careful comparative experiments are made.

The necessity, however, of painting on a greater number of coats requires to be done away with, and will, I think, result in our completely altering our methods of covering large surfaces with white paint, as the use of zinc white becomes customary, the first coat being probably an opaque white coat in some other medium than oil, followed by a coat laid on with a zinc enamel.

Some comparative experiments as to durability of this fashion as against the old fashion of painting require to be made. The belief in the trade is that such methods are shoddy and not durable, yet pictures on canvas, covered first with whiting and size and then with paint in oil, have stood the test of hundreds of years successfully.

Much time and expense can be saved by such methods, and they are well worth the serious consideration of decorators and architects for indoor use. It is possible that for outdoor work they are not so suitable, but even here are worthy of a trial. There is also an impression that zinc oxide paint is not so durable as white lead, but cracks, blisters, dusts and peels off when exposed out of doors.

This used to be explained by the statement that the lead compound in white lead combined with the linseed oil to form a lead soap, which very much increased the durability of the surface. This opinion has now completely altered, and it is now commonly stated that just because such a lead soap is found the paint is less durable. The fact is very little known about the changes which ultimately destroy a coat of paint and the conditions which hasten or retard such changes, and we may well leave the theories out of account.

Careful experiments, however, with wood panels coated with white lead and zinc oxide respectively by a skilled house painter, until equal weights of pigment have been put on each panel, and then exposed to the weather, show conclusively that zinc white gives a far more durable surface. Whether this is due to the excess of oil it contains or to the different properties of the pigments, it is difficult to say, but when the lead panel has become, through exposure, dry, dirty, and impossible to clean because the dirt has penetrated the desiccated surface, which is easily removed by rubbing, the zinc white remains smooth and shining, and if wiped with a wet cloth, as good as the day it was painted.

If pure linseed oil of good quality is used, zinc white will last far longer than white lead out of doors. Half the bad paint is due not to the pigment, but to adulterated oil, which is much the most important factor of the two.

No doubt one of the difficulties which the accustomed user of oxide of zinc suffers from is the larger quantity of oil it contains, as stated above.

For many purposes the oxide of zinc as ground already contains sufficient oil, and only needs the addition of turpentine.

For painting on a completely non-absorbent surface, like iron for instance, no oil is necessary, and a beautiful white enamel surface, with an egg-shell gloss, can be obtained by mixing the oxide of zinc, which contains probably already about 40 parts of oil to 220 parts of zinc oxide, with turpentine alone.

When painting a wood surface in the same way, oil may be added with turpentine to the first coats, but the quantity of oil should be small.

For the final coats no oil is needed unless a very shiny surface is required, a fine egg-shell gloss being obtained with the oil already present in the zinc oxide, with the addition of turpentine only.

If oil is added as freely as in the case of white lead, far more is present than is necessary and the paint, unduly thinned, does not seem to cover the surface. If the thinning is done principally with turpentine, or turpentine substitute, with the addition of little or no oil, each coat of zinc white will be found to have much more body than the house painter supposes who has not studied the peculiar properties of this pigment.

But it is not only as a paint for obtaining white surfaces that we have to consider zinc oxide.

It is now very largely used in the American ready-mixed paint trade as the basis for the various tints, either as pure zinc oxide or as one of the mixed zinc oxide lead sulphate whites, which are obtained by roasting certain ores. To anyone, however, who is used to obtaining his tints with white lead, certain brands of zinc oxide present some difficulties. It is, in the first place, a blue white, while white lead is a yellow white, thus causing a considerable difference in more delicate tints, and in the second place the amount of the pigment required in the case of the two whites is slightly different.

A little exact information on this point may prove useful, and therefore the following experiments with Lovibond's Tintometer may be of some help.

It may be as well, however, to say a few words about this instrument for the instruction of those who are not familiar with it.

It is well known that by the super-position of properly selected blue, yellow and red glasses, of various strengths, almost any tint can be matched.

The Lovibond Tintometer consists of a wooden tube, down which the observer looks. Sufficiently far below the tube to allow light to fall upon them are placed side by side the pigment to be examined and a standard white surface, prepared by pressing pure white calcium sulphate (plaster of Paris) into a little wooden tray. The observer then looking down the tube, sees the pure white surface and the pigment to be examined, let us say for instance yellow ochre, side by side.

Mr Lovibond has, after many years of experimenting, prepared a series of red, yellow and blue glasses of various strengths of tint, which are all numbered, and which are so tinted that, to take an example, the red glass marked 10 is ten times as strong a tint as the red glass marked 1. Moreover, these tints have been so selected that if a yellow, blue, and red glass, each of the same number, be superposed, a neutral tint or grey is produced, a grey which approaches nearer and nearer to a black for the stronger glasses, and to a true white for the weaker glasses.

A red and yellow glass will, when superposed, give orange; a yellow and blue, green; and a blue and red, purple.

To return again to our wooden tube, there are near the front of the tube little grooves into which these glasses can be slid. We now therefore proceed to find the combination of red, yellow and blue glasses which, when placed above our standard white, will produce a tint which matches the yellow ochre. The numbers on the glass will then tell us the amount of red, yellow and blue required to give the yellow ochre tint in terms of the Lovibond Tintometer. A yellow ochre which exactly matched the last one would of course require exactly the same glasses to match it. Now let us suppose that we have two ochres, and we wish to select the one which is the stronger tinter or stainer of the two when mixed with white. If we wish to do this with some exactness, so as to compare the staining power with the price, the best plan is to mix each ochre with known weights of white and take the tintometer reading for each tint produced, and then plot the results on a piece of squared paper, and compare the curves so obtained. If the percentage of white to ochre are measured along the bottom of the paper, and the total numbers of the glasses used added together measured along the side of the paper, we have simply to run along any given horizontal line to find for a given tint the comparative amount of either ochre required.

It is also evident that in the same way if we wish to compare two whites together, such as white lead and zinc white, for the amount of pigment required to tint them, it is only necessary to mix each in known quantities with the same pigment, and take their tintometer readings for comparison.

Once we have in this way tested the tint of a given pigment for various quantities of white, it is no longer necessary to mix in future more than one strength, as we shall have found out what mixture of the pigment with white is most sensitive and shows most change of tint. For instance, yellow ochre should be mixed with white in the proportion of 50 to 50, Venetian reds in the proportion of 10 to 90, to get sensitive mixtures and the most accurate results.

All this will be clearer if we take an actual example. In order to compare snow white, green seal, zinc oxide, with a very fine example of white lead used for artists' purposes, opaque, containing the proper ratio of carbonate to hydrate, and of a brilliant white tint, 9 parts of each, were mixed with 1 part of a fine venetian red, ground stiffly with poppy oil in a hand muller, spread thickly on a glass plate, and examined under the tintometer.

The reading for snow white, green seal, containing 10 per cent. of venetian red, was red 12, yellow 5·2, blue 1·5. Now remembering what has been said above, in the first place the total strength of the mixed paint as measured by the sum of the glasses required to match it was equal to 18·7.

In order to find out of what constituents this tint was composed, we must remember that neutral tint, grey or black, the dulling quality in a pigment is composed of equal portions of blue, red and yellow, and therefore we must substract the amount of blue, from the red and the yellow respectively, leaving us with neutral tint 1·5, yellow 3·7, red 10·5.

Next, remembering that orange is composed of equal values of yellow and red, we subtract the yellow from the red and get as the complete analysis of the colour of the mixed paint. The experiment with the white lead mixed with the red oxide gave the following reading :—Red 12·5, yellow 5·2, blue 2—total light absorption 19.7, and when analysed into its constituents consisting of neutral tint 2, orange 3·2, red 7·5.

It is evident from the readings that in the first place the mixture with white lead is a little stronger than the mixture with zinc white. The oxide of zinc lets down the colour a little more. With good unmixed white lead this ratio is usually taken at about 11 to 12. With this sample it is 18·7 to 19·7.

In the second place, the mixture of the pigment with zinc oxide is a good deal brighter than the mixture with white lead, the neutral tint increasing from 1·5 to 2·0 and forming therefore a much larger percentage of the whole.

In the third place, the mixture, with zinc oxide, is more orange in shade, the orange being 3·7 in the one, and 3·2 in the other. This analysis was confirmed by their appearance, the mixture with white lead having a duller, bluish red look.

We find then for this pigment, and the same is true of other pigments, that while the tints with white lead are a little stronger, the tints with zinc white are much brighter.

This brings us to an advantage which zinc oxide has over white lead, and which has not been sufficiently recognised by many people. Venetian red is a very opaque pigment, and has endowed the zinc white with its own capacity, but the zinc oxide is much bulkier than white lead, and can cover a larger surface. The capacity for covering a larger surface when pure is counterbalanced by the want of body of so thin a covering. When, however, a very opaque pigment like Venetian red is introduced, then we get the advantage of the greater bulk of the zinc white, and can cover a greater surface just as efficiently as the mixture of the Venetian red with white lead can cover a smaller surface.

The extent of the gain of covering power with body or opacity will vary in every case with the pigment used, and the amount of it added. If the pigment is a strong opaque colour like Venetian red, there will be very considerable economy in using zinc oxide in place of white lead to make up the desired tint.

Zinc oxide is therefore the ideal white for making up tints with other pigments, both because the tints are brighter and because a larger surface can be covered with equal opacity to that obtained from the same tint made up with white lead.

CHAPTER VI

MISCELLANEOUS USES OF OXIDE OF ZINC

IN addition to its wide use in paint oxide of zinc is employed in connection with many other industries. For example, when mixed with lard it forms the well-known and most useful zinc ointment, and it is also used in various forms in pharmacy, *e.g.*, as a dusting powder, as a cosmetic and as a tonic. It is used also in rubber manufacture—40 per cent. being the maximum allowed in Admiralty specifications—in the manufacture of glass for optical purposes, as a white colouring matter in pottery glazing, as a filling for oil and floor cloths, in preparing designs for laces and other textiles, as a hygienic preparation, by wallpaper manufacturers for backgrounds, to give body to colour and glazing, and in many other ways.

Appended are a number of recipes the greater number of which have been compiled from the writings of Mr. W. G. Scott, who recently won a valuable prize for his essay on " Zinc Oxide and its Uses."

Water colours may be mixed with a distemper liquid, without grinding, and produce a very good paint, but are far better when ground.

Oil colours, unlike water colours, are very unsatisfactory when simply mixed with the paint vehicle, therefore to obtain the best results it is imperative that they be ground in a paint mill before being mixed with the thinners.

The finer the paints are ground, the better the result in regard to covering capacity, hiding power, tinting quality, and durability. Furthermore, coarse pigments settle far more rapidly than finely ground pigments.

In some cases, as vermilionettes, the pigment cannot be ground as fine as desired, on account of the crystals being broken, and a yellow tone imparted to the paste. Such cases are rare, and a great advantage of the zinc oxide is that it will stand any amount of grinding without being affected.

In grinding, the dry pigment is mixed with a given measure or weight of oil, and the paste is then ground in a stone or iron paint mill.

For very fine grinding the mills should be "water cooled," to prevent heating of the paint.

The thickness of the ground paste will depend upon the size and kind of mill used, a large stone mill being able to handle an extra "stiff paste," whereas, in an iron mill, it will only be possible to grind what is termed as "medium paste."

A "stiff paste" is generally made in a "chaser" or edge runner machine previous to grinding, while a "medium paste" may be made by incorporating the pigment and oil by agitation, or stirring in a "pony mixer."

A stiff mix of white lead or zinc oxide will generally require a 24 to 36 inch stone mill for grinding, whereas in the case of a medium mix the paint may be ground in a 12 inch iron mill.

It is obvious that a stiff paste will contain more pigment and less oil than a medium mix, as shown in the two following examples :—

"Stiff or Thick Paste." (Large Stone Mills).

(a) 92½ lb. Dry White Lead.
7½ lb. Raw Linseed Oil.
(b) 35½ lb. Zinc Oxide.
7⅛ lb. Raw Linseed Oil.

"Medium Paste." (Iron Mills).

(c) 62¼ lb. Dry White Lead.
7½ lb. Raw Linseed Oil.
(d) 23½ lb. Zinc Oxide.
7½ lb. Raw Linseed Oil.

It will be noticed that the proportional difference in pigment is about one-third less for the medium mix.

The regular paint grinders use stone mills, and turn out thick pastes (unless oil is very cheap).

Of late years many of the large manufacturers of agricultural implements, machinery, etc., have been grinding their own primers and second coat colours, using as a rule the less expensive water-cooled iron paint mills.

The regular paint grinder has his own particular lot of formulas, therefore the following formulas are designed for the latter class, and the amount of oil is figured for the "medium mix." If a stiff paste is desired, increase the dry pigment by about one-half.

LABORATORY WHITE PAINT.

55 lb. Pure White Oxide.
35 lb. Lithophone.
10 lb. Floated Silica.
3 gallons Raw Linseed Oil.
$\frac{1}{2}$ gallon White Grinding Japan.
$\frac{1}{4}$ gallon Turpentine.

This paint is unaffected by sulphur fumes, gases, light, air and ammonia or acid fumes.

It dries with an egg-shell gloss, remains snowy white, and is very durable.

CHEAP ZINC PRIMER.

60 lb. Common Zinc Oxide.
35 lb. Gilder's Bolted Whiting.
5 lb. Floated Silica.
3 gallons Raw Linseed Oil.
$\frac{1}{8}$ gallon Crystal Drier.

This paint is very adhesive, and becomes exceedingly hard in time. The silica prevents scaling, due to moisture in the wood.

For dipping paints the paste is thinned with benzine, or a mixture consisting of 9 parts of benzine to 1 of oil, until a Beaume Hydrometer sinks to about 55° (1.611 Sp. gr.).

For one coat work the hydrometer should stand at about 64° B. (1·790 sp. gr.).

Brush consistency is attained with the following gravities :—

Primer—60° B. (1·706 sp. gr.).
Second coat—66° B. (1·835 sp. gr.).

The hydrometer generally used is Beaume's Hydrometer for heavy liquids, the scale reading from 72° to 50°.

With slight variations, all dipping paints may be thinned to the proper consistency by means of a hydrometer.

The paste primer may be tinted any desired colour by adding the proper pigment ; thus 5 lb. of Venetian red ground with the above gives a pink primer.

" PREMIUM " WHITE.

60 lb. White Lead (Carbonate).
30 lb. Common Zinc Oxide.
10 lb. Floated Silica.
2 gallons Raw Linseed Oil.

This is one of the most durable whites known, and is superior to any of the single pigment paints ground in oil.

The lead gives it toughness, the zinc imparts hardness and purity of colour, and the silica renders it porous enough for the moisture to escape from the wood.

ZINC ROOF PAINT (GREY).

25 lb. Silver Lead (Plumbago or Graphite).
15 lb. Floated Silica.
10 lb. Common Zinc Oxide.
3¼ gallons Raw Linseed Oil.
¼ gallon Oil Drier.

This is intended for metal roofs, shutters, etc.

ELASTIC IVORY WHITE PAINT.

50 lb. "Green Seal" Zinc Oxide.
1 gallon Raw Linseed Oil.
½ gallon Nonpareil Japan.
½ gallon Camphorated Turpentine.

This paint dries with a dull lustre, and is as tough as horn. It is designed for sheet metals, subject to a slight bend.

The Camphorated Turpentine is made by dissolving 8 oz. of Camphor in 1 gallon of Turpentine.

WHITE ENAMEL PASTE.

30 lb. "Green Seal" Zinc Oxide.
20 lb. Lithopone.
2 oz. Ultramarine Blue (cobalt blue shade).
1¼ gallons White Enamel Varnish.
½ gallon Bleached Linseed Oil.
½ gallon Camphorated Turpentine.

For use, 48 lb. of the above paste is mixed with :—

1½ gallons White Enamel Varnish.
½ gallon White Damar Varnish.
¼ gallon Solvent Naphtha.

Turpentine may be used in place of solvent naphtha if desired, but it exerts a flatting effect.

GLOSS ZINC (IN DAMAR).

75 lb. Pure Zinc Oxide.
1 oz. Ultramarine Blue (cobalt shade).
5 gallons Pure White Damar Varnish.
¼ gallon Turpentine.
⅛ gallon Poppy Oil.

This paint was formerly used as an interior finish, but has been superseded of late by the enamels.

RADIATOR WHITE PAINT.

22 lb. Common Zinc Oxide.
10 lb. Barytes (superfine).
3 lb. Pulv. Soapstone.
$\frac{1}{2}$ gallon Japan Gold Size.
$\frac{1}{4}$ gallon Turpentine.
$\frac{1}{4}$ gallon Carbon Tetrachloride.

This paint dries very flat, and is not much discoloured by heat. If preferred, it may be ground in a celluloid mixture, in which case there is no discolouration.

WHITE JAPAN COLOUR.

25 lb. Common Zinc Oxide.
25 lb. Lithopone.
1 gallon White Grinding Japan.
$\frac{1}{4}$ gallon Turpentine.
$\frac{1}{8}$ gallon Bleached Linseed Oil.

Japan colours dry exceedingly fast, and with a flat surface. For striping purposes the very little grinding japan should contain very little gum, as the gum has a tendency to make the brush " drag," and shortens the length of the line.

Colours ground in japan are usually termed " Superfine Colours," and, as the name implies, should be ground extra fine. Conclusion. In specifying the name of the maker of a certain japan or varnish, it does not follow that such particular brand is to be used, but it is imperative that a similar liquid be adopted.

Any reliable varnish house will recognise the kind of material mentioned in the above formulas, and can furnish equally satisfactory goods.

The foregoing recipes all call for more or less zinc oxide, a fact which bears out the assertion that no other pigment has such a diversity of uses, and it can be used with impunity in admixture with any and all other colours, and with any kind of a paint vehicle.

SILICATE WHITE FIRE AND WATERPROOF PAINT.

$\frac{1}{8}$ oz. Pulv. Borax, dissolve in
1 fl. oz. Hot Water, then mix with
4 fl. oz. Silicate of Soda, about 36° B.
When well mixed, add
$\frac{1}{2}$ fl. oz. Light Coloured Syrup. Finally stir in
4 oz. Common Zinc Oxide.

Silicate paints are used for fire-proofing wood, paper and canvas. They are very adhesive, and set quite rapidly. Owing to their alkaline character they cannot be used with colours or fabrics affected by alkalies.

Stone or brick painted with ordinary silicate paint may be rendered water-proof by giving the dry silicate coat a wash of Ammonium Chloride (Sal Ammoniac) or of Calcium Chloride. Such solutions are made by dissolving 1 part of the salt in 8 to 10 parts of water.

SILICATE WHITE FIRE-PROOF PAINT.

4 fl. oz. Silicate of Soda—36° B. (1·330 sp. gr.).
2 fl. oz. Water.
$\frac{1}{4}$ fl. oz. Glycerine, mix all together, then add
4 oz. Common Zinc Oxide.

Solution of silicate of soda of 26° B. gravity is about the consistency of a good flowing varnish. Glycerine, sugar or treacle is added to impart flexibility and prevent the soluble glass from setting too quickly.

Zinc Whitewash.

(a) 2 oz. White or Transparent Sizing Glue.
16 fl. oz. Cold Water. Soak 2 hours, then dissolve on water bath.

(b) ½ oz. Ivory Soap (cut in shavings).
4 fl. oz. Boiling Water. After mixing and while warm, add
16 oz. Common Zinc Oxide.

This is a fine whitewash, and works easily under the brush. The soap prevents trouble from suction.

Ordinary lime whitewash may be made whiter and better by adding about ten per cent. of zinc oxide.

Sanitary Zinc White Paint.

(a) 1 oz. French or German Gelatine.
16 fl. oz. Cold Water. Soak 1 hour, then dissolve on water bath.

(b) ¼ oz. Zinc Chloride.
⅛ oz. Chrome Alum, dissolve in
8 fl. oz. Hot Water.
Mix (b) with (a), then stir in
12 to 16 oz. Common Zinc Oxide.

The above is designed for a wall finish, and resembles celluloid in appearance.

Anti-Rust Paint.

Zinc, combined with red lead, or with graphite, forms a splendid paint for structural iron work, and by many is preferred to straight red lead.

60 lb. Red Lead.
30 lb. Zinc Oxide.
10 lb. Plumbago (Graphite) ground in
2½ gallons Raw Linseed Oil.

The colour of this paint is a reddish-chocolate ; it is quick drying, and will not separate in streaks like red lead in oil.

All red lead mixtures harden in a very short time, consequently the paint should not be ground up too long a time previous to using. A small amount of beeswax dissolved in the oil (½ oz. to the gallon) will retard the hardening, so likewise will an addition of China clay or alumina hydroxide to the pigment. For fire-proof purposes, boracic acid, sulphate of ammonia or sal ammoniac in fine powder, is added to the mixed paint in the proportion of about half a pound to the gallon.

Zinc oxide, with vermilionettes or the orange chromates, also furnishes a splendid paint for metals, and is a great rust preventive.

IMITATION "SLATE ROOFING" PAINT.

This is another paint in which zinc oxide plays an important part ; the formulæ is as follows :—

20 lb. Leaded Zinc.
10 lb. Whiting.
5 lb. Portland Cement.
15 lb. Graphite.
1 lb. Lamp Black. Grind in
3 gallons Boiled Linseed Oil.

This makes a fine paint for metal roofs ; it is of a dark slate colour or grey, but may be made into a beautiful deep olive green by substituting 2 to 5 lb. of chrome yellow in place of the lamp black.

This paint is to be thinned with boiled oil ; some painters use it for shingles, in which case they thin it with two parts of boiled linseed oil and one part of kerosene oil. Strange as it may appear, the kerosene mixture gives wonderful durability on wood ; on metal, however, it is a flat failure, as the kerosene is unable to penetrate the material.

In conclusion, it may be said that for either exterior or interior work there is no pigment more generally used than zinc oxide, nor one that gives so little trouble in painting.

CASEIN FLEXIBLE WHITE PAINT.

1 oz. Casein, mix free from lumps in
2 fl. oz. Cold Water, then dilute with
8 fl. oz. Water, then add
¼ fl. oz. Strong Ammonia, stir and add
2 fl. oz. Glycerine.

To the above solution add 8 oz. of Common Zinc Oxide to get a paint of brush consistency.

The pigment and liquid should be well mixed with the brush to get rid of lumps.

This paint is very pliable, and is suitable for paper, leather, and other flexible substances.

COMMON CASEIN WHITE PAINT.

(a) ¼ oz. Pulv. Borax, dissolve in
14 fl. oz. Hot Water.
(b) 1 oz. Casein, mix until free of lumps, with
2 fl. oz. Cold Water

Add (b) to (a), mix well, then stir in 16 oz. Common Zinc Oxide.

If the mixture be whipped with an ordinary revolving egg-beater, the lumps will be removed, and the consistency improved.

More or less dry oxide may be added according to the consistency desired.

OLEO-CASEIN WHITE PAINT.

1 oz. Casein, mix with
2 fl. oz. Cold Water, then dilute with
12 fl. oz. Water, stir well, then add
¼ fl. oz. Strong Ammonia, next add
1 fl. oz. Glycerine. Finally add
6 fl. oz. Raw Linseed Oil. Mix thoroughly, then stir in
8 oz. Common Zinc Oxide.

This paint may be used as a primer on wood, paper, etc. It is water-proof, and very elastic. More pigment may be added if desired, and it can be thinned with water, alcohol, oil, turpentine, or benzine.

All of the Casein paints containing ammonia lose the greater part of the alkali on standing, but this does not affect the quality.

NOTE.—All water colour formulas are reduced to the smallest convenient measure or weight. In making up a large quantity it is only necessary to multiply each constituent measure or weight by a certain number to obtain a given quantity of paint.

SPIRIT WHITE ENAMELS.

Zinc Oxide ground in alcohol may be used to produce many kinds of white enamels. In making such paints it is better to have the spirit varnish quite thick, as the alcohol in the ground paste has a tendency to dilute the solutions.

The varnishes used for this class of enamels arc as follows :—

SHELLAC SOLUTION.

1 lb. White Shellac, dissolved in
32 fl. oz. 95 per cent. Alcohol.

SANDARACH SOLUTION.

1 lb. Sandarach, dissolved in
32 fl. oz. 95 per cent. Alcohol.
When dissolved, add
2 fl. oz. Venice Turpentine.

CELLULOID SOLUTION.

4 oz. Soluble Gun Cotton, dissolve in
32 fl. oz. Amyl Acetate. Let stand 10 hours, then add
32 fl. oz. Amyl Acetate. Finally add the following solution :—
1 oz. Camphor Gum, dissolved in
8 fl. oz. Acetone.

All of the above varnishes are thick, and are designed for white enamels. The two former may be thinned with alcohol, but the latter must be thinned with amyl acetate, ether, or acetone. Turpentine and benzine precipitate the cotton.

Camphor gum has the peculiar property of making other gums flexible ; it may be added to any spirit varnish, but the amount should not be very large, except in the case of the celluloid varnishes, where it may be 25 per cent. of the gun cotton. One ounce of camphor to a gallon of shellac or sandarac varnish is sufficient.

ZINC CEMENTITE.

1 oz. White Dextrine.
1 oz. Wheat Flour.
4 oz. Plaster of Paris (dental plaster).
2 oz. Zinc Oxide.

All of the above are thoroughly mixed together. For use, the powder may be mixed thin with cold water, and the solution used as a paint, or mixed thick and used as a putty, stripple mixture, or raising preparation.

When dry, this filler is as hard as stone. By increasing the flour it may be more elastic.

PAPER BOX WHITE.

(a) 1 oz. Wheat Flour, beat free from lumps, in
2 fl. oz. Cold Water, then pour into
14 fl. oz. Boiling Water. Stir until paste thickened, then remove the heat.
(b) $\frac{1}{2}$ oz. Sulphate of Zinc.
$\frac{1}{8}$ oz. Pulverized Alum.
$\frac{3}{8}$ oz. Common Table Salt. Dissolve in
4 fl. oz. Hot Water. Mix (b) with (a), then stir in
(c) 1 oz. Pulverized Soapstone.
3 oz. Gilder's Bolted Whiting.
5 oz. Leaded Zinc Oxide.

This is a cheap preparation designed for painting pasteboard

MATT ENAMEL WHITE, FOR PAINTING PAPER AND OTHER FLEXIBLE SUBSTANCES.

(a) 1 oz. French Gelatine (colourless).
16 fl. oz. Cold Water, soak 1 hour, then dissolve on water bath.
(b) 2 fl. oz. Glycerine.
4 fl. oz. Water.
5 drops Formaldehyde (40 per cent. solution).
Add (b) to (a), stir well, then mix in
(c) 4 oz. China Clay.
20 oz. Common Zinc Oxide.

ZINC OINTMENT.

Zinc Ointment (*Unguentum Zinci Oxidi*) is made as follows :—

Take of pure oxide of zinc 80 grains, benzoated lard 1 ounce (avoir.), melt the lard at a low temperature, add the dry oxide, and stir the mixture constantly while it cools.

" Benzoated Lard " is prepared in the following manner :—Benzoin in coarse powder, two parts (140 grains) ; Lard, one hundred parts (16 ounces, avoir.). Melt the lard by means of a water bath, and, having loosely tied the Benzoin in a piece of coarse muslin, suspend it in the melted lard, and, stirring them together frequently, continue the heat for two hours, covering the vessel and not allowing the heat to rise about 60° C. (140° F.). Lastly, having removed the bag of benzoin, strain the lard, and stir while cooling.

Zinc adhesives used for coating muslin or canvas, one side of which is painted with the sticky mixture. This is one of the strongest adhesives known, and is used very extensively by surgeons and chemists. It is water-proof, antiseptic, and non-poisonous ; owing to the mass of softening in hot water, it is easily manipulated. The regular formula for making the adhesive mass is as follows :—

ZINC ADHESIVE MASS.

1 oz. Gutta Percha, dissolve by heat in
2 fl. oz. Venetian Turpentine, or Balsam of
of Fir, add while hot
3 oz. Pure Zinc Oxide.

Any of the balsams may be used in place of the above ones named, and extra adhesiveness may be imparted by increasing the amount of balsam or turpentine.

A similar preparation, to be used as a cement or putty, is made as follows :—

ZINC STOPPING PUTTY.

1 oz. Gutta Percha, dissolve by heat in 1 fl. oz. Venetian Turpentine, add while hot 1 oz. Common Zinc Oxide and ½ oz. Red Lead or Litharge.

It requires about half an hour to dissolve the gutta percha in the hot Venice turpentine, and the mixture should occasionally be stirred to facilitate solution.

CASEIN WATER-PROOF WHITE.

1 oz. Casein, stir until free from lumps in
2 fl. oz. Cold Water, then dilute with
4 fl. oz. Water, then add
½ fl. oz. Strong Ammonia. When well mixed add
¾ fl. oz. Chrome Alum Solution (1 to 10), finally add
4 fl. oz. Wood Alcohol.

The above mixture makes 12 fl. oz. of liquid, and if 6 oz. of Pure Zinc Oxide, or an equivalent weight of the heavier zinc oxides be mixed with this solution, it will form a paint of brush consistency.

When dry, this paint is perfectly water-proof and fire-proof.

The Chrome Alum Solution is made by dissolving 1 oz. of Chrome Alum in 10 fl. oz. of water.

Formaldehyde (40 per cent. solution) may be used in place of Chrome Alum if desired, in which case 60 drops will be sufficient for the 12 fl. oz. of casein solution.

APPENDIX

THE PREPARATION AND MIXING OF OXIDE OF ZINC PAINTS TO SUIT VARIOUS CONDITIONS AND CLASSES OF WORK

By J. Cruickshank Smith.

The following paper was awarded a prize in a competition offered by *The Decorator* :—

PART I

INTRODUCTORY, DESCRIPTIVE AND GENERAL

Scope and Object.

The object of the following paragraphs is to offer suggestions as to the best working formulæ for the preparation and mixing for use of Oxide of Zinc Paints, with special reference to the nature and quantity of driers to be employed.

CONDITIONS PECULIAR TO THE APPLICATION OF PAINTS.

The wide scope and complexity of the subject are apparent from even a cursory glance at the various aspects of the question.

In the first place, the information sought for has to be applied to every-day work by painters, who, however careful, however intelligent, however highly trained in their own craft they may be, are debarred by the very exigencies of their calling from measuring quantities and working generally with that precision and attention to details which are rightly looked for in the chemist in his laboratory.

Again, it is a necessary axiom in connection with all formulæ for the mixing of paints by the painter himself that the nature of the surface must be taken into consideration, and hence working formulæ should be built up in such a manner and the ingredients should be of such a nature as to permit of slight deviations from the strict formula without prejudice to the specific result aimed at. This consideration does not, one readily admits, apply in cases where the surface itself and each individual coat of paint on it are of known and definite composition. Under these conditions no deviation from a standard formula is necessary, but in actual practice this state of affairs obtains but rarely.

It might be argued that a formula for a mixed paint ought to be as invariable in its character as that, for example, which governs the composition of an enamel or a varnish. It must be remembered, however, that the conditions which obtain in ordinary painting work are by no means comparable with those which have to be faced when an enamel or varnish is about to be used, for the simple reason that in the latter case the enamel or the varnish constitutes the *final coating*, and is presumed to be applied on a surface of *definite character*. In the case of the application of paints, the conditions are entirely different, as the surfaces on which the paint is applied vary to an indefinite extent. It is obvious, therefore, that on the first and preliminary coats of paint, at any rate, a certain amount of latitude must be left to the craftsman who is applying the material, although as the surface becomes filled and "bodied up," he is able to adhere more and more closely to a definite formula.

It is necessary, then, that formulæ which profess to furnish the correct proportions of the various ingredients in paints to be used for specific purposes should be capable of being varied *with discretion and strictly within limits* to suit those variations in the physical nature of the surface which every practical painter meets from day to day, and which long experience has taught him cannot be dealt with by rigid cast iron methods.

Questions relating to temperature and humidity in the atmosphere also introduce extraordinary complexity into our subject, and with some of these questions we shall deal in due course.

PRELIMINARY CONSIDERATIONS.

In order that we may approach our main enquiry with some degree of assurance, it appears necessary to consider briefly at the outset the fundamental facts and principles of paint mixing, or, at any rate, that portion of it which pertains to oxide of zinc.

The form in which oxide of zinc (considered as a painter's raw material) comes into the hands of the painter is that of " oxide of zinc ground in oil," and it may be well for us to note at the outset to what extent this material is capable of variation. In commercial language the words " oxide of zinc ground in oil " imply practically no guarantee as regards quality or even purity. It is doubtful whether without the word " genuine " prefixed to " oxide of zinc " the expression could be held to exclude adulterated brands of oxide of zinc. In order, therefore, to eliminate all possibility of misconception on this point, it is well that purchasers of the material should describe it by the name " genuine oxide of zinc ground in oil."

VARIATIONS IN PIGMENT AND OIL.

But the term " genuine oxide of zinc " is by no means a fixed quantity. The pigmentary material varies within somewhat wide limits as regards colour, fineness and hardness of particles, opacity, and the like. Consequently the intrinsic value of the dry pigment is liable to vary.

It would appear wise under these circumstances for the user of oxide of zinc paints (and it need hardly be remarked that users of such paints include many who are not merely house-painters and decorators) to protect themselves against the possibility of obtaining oxide of zinc paint made from dry oxide of zinc of indifferent or inferior quality, and the suggestion offered is that the paint should be specified to contain dry oxide of zinc of a quality equal to some well-known standard brand. The brand of oxide of zinc which may be looked upon as a standard of purity and uniformity is probably that manufactured by the Vieille Montagne Company. Thus, if one specifies that the dry oxide of zinc employed in a certain parcel of genuine oxide of zinc paint is to be equal to the " red seal " or " green seal " oxide of zinc manufactured by the Vieille Montagne Company, one has a fairly good guarantee that the quality of the oxide of zinc will be a definite quantity. In mentioning this particular brand, it must not be understood that the writer is throwing any slight on other brands, which may be, and in many cases no doubt are, equally good. The point is that it is necessary to have some sort of standard, and as the name in question is probably the oldest and most important among the oxide of zinc manufacturing houses, good reason appears to exist why its products should be taken as standards.

But we have not exhausted the points in connection with which oxide of zinc paints may vary in quality. The oil is an important source of variation, and one over which the user of the paint has very little control. If he desires to protect himself as far as is possible in this connection he might with advantage introduce words to the following effect into the specification :—" The oil in the paint to consist of pure refined linseed oil well matured, and of good drying power."

A DEFINITION.

In the course of the remarks which follow it will be necessary to allude not only to the paint thinned and mixed for use (which the painter refers to simply as " paint "), but also to the painters' raw material, the pigment ground in oil. For the sake of convenience, therefore, we shall refer to the latter as " stiff paint," and to the former as " mixed paint."

SPECIFICATION OF THE STIFF PAINT DESIRABLE.

It may seem strange to some persons to suggest that any attempt at specifying the composition of the stiff paint should be made by the user of that article. Everyone, however, who is acquainted with the paint trade knows to what an extent large users of white lead paints specify, and that in a very definite manner, the composition of their white lead paint. Railway Companies, Engineering Companies, large Contractors and export Shippers, as well as some Builders, frequently purchase white lead on the basis of definite specification as to composition and quality. Why should not the same procedure be adopted with regard to zinc paints, which are liable, unless carefully watched, to present just as much variation in quality as do white lead paints ?

A FUNDAMENTAL DISTINCTION BETWEEN LEAD AND ZINC STIFF PAINTS.

The proportion of oil in oxide of zinc stiff paint is a matter of some importance. Careful examination of a number of samples of genuine oxide of zinc stiff paint purchased in the open market in Britain has disclosed the fact that in the best brands the proportion of oil amounts to from 20% of oil to 21%, and trials conducted in the paint works have proved that really first-rate dry oxide of zinc requires about 25% of oil on the weight of dry pigment to reduce it to a suitable paste, and 25% on the dry pigment represents 20% on the weight of the stiff paint. Some Continental makes of stiff zinc paint contain as much as 33% of oil, and some English brands are ground with as little as 14%. The latter figures, however, are extremes, and 20% of oil in the stiff paint may be looked upon as a standard quantity.

Now in the case of white lead a great difference has to be noted, inasmuch as white lead ground in oil contains, in the case of the best brands, no more than 7% of oil, and the practical result of this is that whereas 100 lbs. of genuine ground white lead contains 7 lbs. of linseed oil, 100 lbs of genuine oxide of zinc paint contains 20 lbs. of linseed oil. Not only so, but another fundamental fact must be noted, namely, that the oxide of zinc which, in the form of finely ground pigment, is distributed throughout the oil in the stiff paint is entirely without drying action on the oil, while in the case of white lead paint the oil which it contains possesses definite drying powers on account of the drying properties which hydrated carbonate of lead communicates to linseed oil. Hence, whereas 100 lbs. of stiff white lead paint contain 7 lbs. of oil, which, by reason of the chemical properties of white lead, is practically drying oil, 100 lbs. of oxide of zinc paint contain 20 lbs. of oil, which is simply raw linseed oil in its original state.

A Deduction from the Foregoing Facts.

A consideration of the facts we have enumerated seems to point to the necessity for counteracting the want of drying power in the oxide of zinc by the use of an oil in thinning the paint which shall contain the drying properties which the stiff paint lacks. It is undoubtedly in connection with this question of drying that zinc paints have proved troublesome in practice to the painter, and the use of paste or so-called " patent " driers has not been attended with success.

General Remarks on Driers.

A fairly complete series of experiments has shown that a drying linseed oil can be prepared with the greatest ease and at a very low price. The principle underlying the preparation of such an oil is the fact that certain chemical materials dissolve very readily in warm oil and in solution communicate to the oil marked drying properties, whereas the same bodies added to or mixed with the cold oil do not act with anything like the same degree of potency.

It must be borne in mind that in the preparation of such a drying oil as that indicated above *all substances containing lead must be tabooed.* If lead is to be admitted as a constituent of zinc driers the problem becomes immensely simplified, but, on the other hand, if lead is to be admitted one of the main *raisons d'etres* for using zinc paint disappears. Indeed, to permit the inclusion of lead in any shape or form in driers for oxide of zinc paint is simply to beg the question. We are, therefore, driven to employ driers of another nature, and the following list includes practically all of those which are capable of utilisation :—

Borate of Manganese
Sulphate of Manganese
Linoleate of Manganese
Resinate of Manganese
Dioxide of Manganese
Tetroxide of Manganese

The sulphate may be eliminated for the reason that it is more suitable in a water solvent than in an oil solvent, and the presence of water in driers cannot be too strongly condemned. It is also liable to communicate a pink colour to white paint. The dioxide and tetroxide of manganese are applicable only in the preparation of drying oils of fairly dark colour. The borate, linoleate, and resinate of manganese are all useful and effective drying agents. Resinate of manganese, as it appears in commerce, however, is largely contaminated with free rosin for the reason that commercial resinate of manganese is manufactured by the fusion of the metallic oxide with rosin, and therefore consists of resinate of manganese dissolved in a large excess of rosin. As anything in the shape of rosin is strongly objection able in connection with paint materials the resinate is, apart from the question of colour, out of court.

This leaves only the borate and the linoleate, and for reasons of convenience and relative strength in comparison with price preference must be given to the borate.[+]

A very simple experiment will prove the drying

[+] This was written in 1906. More recent work leads the author to prefer the linoleate in many cases.—*J.C.S.*

properties of borate of manganese. To 100 parts of well-tanked linseed oil add 0.25% of finely powdered borate of manganese, distribute thoroughly through the oil, and gently heat the oil up to a temperature at which fumes are given off, but not sufficiently high to char it. If a little dry air is passed through the oil during the heating process so much the better. Finally allow the oil to cool and settle, and when cold test the drying power by pouring on a slip of glass and comparing the result with oil which has not been treated in this manner.

A similar experiment may be carried out by employing cold oil and mixing it with a sufficient proportion of borate of manganese to produce the same drying result. It will be found that a very much larger proportion of manganese salt will be required in the case of the cold oil.

THE BEST OIL MEDIUM.

The writer's suggestion is that if an oil prepared in some manner similar to that described above were used as the oil medium in thinning oxide of zinc paint for use the paint would at once be placed on equal terms with white lead paint, which contains, as we have already seen, a proportion of drying oil, and voluminous experiments which have been made with paints prepared from an oil of this description have proved eminently satisfactory.

There is a prejudice on the part of many painters against the use of boiled oil in paints, and it is fair to say that in many cases their objection to boiled oil is well founded. When a paint manufacturer prepares " ready mixed " paint he uses powerful machinery, and he can get boiled oil to amalgamate with practically any stiff paint he likes. But in the case of a painter working with hand appliances the matter is different, and it has been found that boiled oil does not readily amalgamate with many paints, among them oxide of zinc paint. It is undoubtedly the case that pale boiled oils (of which there are several on the market) give, so far as durability goes, good results when used as ingredients of mixed oxide of zinc paints, but the painter always finds a difficulty in mixing these oils with stiff zinc paint. By employing a drying oil as suggested above this difficulty is entirely done away with, as a prepared drying oil of the kind described does not possess that viscous greasy nature which renders amalgamation with stiff paint difficult. In fact, so far as appearance goes, the oil is hardly altered unless the air blowing process be carried to excess, and this should not be the case. The preparation of such an oil is of course primarily a matter for the manufacturer to tackle, but the matter is also one in which the user of the paint can give great assistance, and the assistance which he can give will be in the direction of welcoming, or, at any rate, testing in a fair and enlightened manner what the manufacturer has to offer him. Unfortunately the attitude of many paint users towards improvements in connection with paint materials is somewhat hostile, and that great bugbear, "price," is liable to step in and undo much good work.

INDIFFERENT LINSEED OIL.

It is an undoubted fact that during the last few years an immense quantity of linseed oil of very indifferent quality has been used in painting work. Possibly this oil may have cost the painter a penny or two less per gallon than oil of approved quality, but he has assuredly not gained in the long run. If the user of paint would be content to pay a fair market price for his linseed oil, then the preparation which I have outlined in order to make it a suitable drying oil for zinc paints could be applied to it at very small extra cost, the only requirements of such an oil being that it be not too expensive, and that it be pale in colour and uniform in quality and drying power.

It may be well to add that although the use of a prepared drying oil is to be strongly recommended, and the results obtained by its use have been most encouraging, circumstances may arise in practice which drive the painter back to the use of ordinary linseed oil. In such cases all one would say is : use the best and palest linseed oil procurable. In the formulæ which appear later indications are given as to what variations in the proportions of drier are necessary to suit the oil medium used.

THINNING THE STIFF PAINT.

So much for the oil portion of the mixed paint. We have now to consider the general process for reducing the stiff oxide of zinc paint to the proper mechanical or working consistency. In round figures, one cwt. of stiff oxide of zinc paint requires four gallons of thinning material. This thinning material necessarily varies in composition according to the nature of the surface to be painted, and the nature of the surface which it is desired to produce. Thus the four gallons may be made up of three gallons of oil and one gallon of turpentine or of equal parts of each, or with a preponderating proportion of turpentine.

I would repeat that these figures are to be regarded as typical and approximate ones, and are given merely as indicating an intermediate step towards the goal we are endeavouring to arrive at, viz., exact formulæ to suit different conditions.

Instead of expressing paint mixtures in terms of pounds, gallons, or pints, it is preferable whenever possible to state them in terms of some simple unit, or as percentages by weight. Thus, instead of saying that one cwt. of oxide of zinc paint requires in the case of certain conditions two gallons of linseed oil and two gallons of turpentine to reduce it to the proper consistency we may state the proportion as follows :—

	Parts by Weight.
Oxide of zinc in oil	100
Linseed oil	16
Turpentine	14

And these numbers may represent cwts., or pounds, or ounces, or any other unit of weight which may be decided upon according to the size of the mixing required. One reason why reduction to a single unit of weight is to be recommended is that it tends to make workmen more careful in measuring out the material. The average workman is so familiar with the term " gallon " that he thinks he knows exactly what a gallon is, and consequently does not always trouble to measure it. The result is that in practice one frequently finds that a so-called gallon may be a gallon and a half or three-quarters of a gallon.

THE DRYING MATERIAL IN MIXED OXIDE OF ZINC PAINT.

The general formula just given is, of course, merely a skeleton formula, and is obviously incomplete. It says nothing about "driers," and with the mention of this word we get into the heart of our subject.

The problems connected with the drying of paint are two-fold. First, it is necessary to induce the skin of paint to harden within a reasonable time in order to prevent it being damaged or destroyed by mechanical abrasion or by dust adhering to it. In the second place, it is necessary to prevent the film drying so quickly or so strongly as to make its ultimate destruction inevitable. If we consider the drying of a varnish film, we find that it dries regularly and uniformly throughout, if it be of proper thickness. A paint film should dry in the same manner, and not only on the surface. If a paint film dries only on the surface it is usually because the film of paint is too thick for the oxidising action to proceed through the skin that is first formed on the top, but it may also be because the drying has set in so quickly on the surface that the under portion is protected, so to speak, from further drying action.

It is obvious that the greater the proportion of oil in the mixed paint the greater the amount of drying material which must be introduced. Contrariwise, the more turpentine the paint contains the less drier is required, partly owing to the reduced proportion of oil, and partly owing to the fact that turpentine is in itself a drier or promoter of drying.

THE TRUE ROLE OF A PAINT DRIER.

It is necessary to have a clear conception of the duties a paint drier is intended to perform. The fact must not be lost sight of that all paints of good quality contain as an essential ingredient linseed oil, which is capable under definite conditions of becoming oxidised in a manner which is only imperfectly understood. The *results* of the oxidation are familiar enough, however, and consist of the formation of a tough skin. Now nothing that any drier possesses in itself helps in the production of this skin directly. All the drier can do, and should be expected to do, is to assist in the interchange of oxygen, moisture, etc., between the oil and the air, the result of which is the so-called " drying " of the oil. The " drying power " is in the oil ; the drier merely starts the action off and helps it along. An oil that is deficient in drying properties can only be made to dry " at the point of the bayonet" as it were, that is by the use of a large excess of drier, and it is for this reason that so much emphasis is laid on employing a good drying oil.

No confusion should be allowed to arise between the *drier* properly so called which we are now discussing and the *prepared drying oil* already referred to. The latter material is simply a substitute for ordinary refined linseed oil prepared in a manner which experience has proved to be satisfactory with a view to counteracting the entire lack of drying properties in oxide of zinc.

HUMIDITY AND TEMPERATURE AS AFFECTING THE DRYING OF PAINTS.

There cannot be the least doubt that the phenomena of drying constitute one of the most abstruse problems with which we are confronted in the study of paints. In Britain the matter is even more complex than in some other parts of the globe. Both in America and on the Continent where zinc paints are largely used the drying conditions are, if not absolutely better than they are in Britain, more uniform, this being to a large extent due to the greater dryness of the atmosphere than is the case here. The humidity of the climate of this country is undoubtedly at the root of many of those troubles in connection with the drying of paints with which every paint user is so familiar, and this lack of uniformity in one of the essential conditions of drying makes it exceedingly difficult to give formulæ for the composition of paints which can be relied upon to be absolutely correct in every conceivable case.

Temperature also affects the drying of paint, but researches which are still uncompleted tend to show that the question of temperature is very much bound up in that of humidity. Low temperatures are often accompanied by considerable humidity. Of course, at a summer temperature drying takes place very much more readily and uniformly than at a low temperature. Nevertheless a low temperature is not always responsible in itself for the slow drying of paint. "The stagnation of moisture," if we may so describe it, is in many cases the inducing cause.

Some remarks by Mr. Walter J. Pearce in his standard book on "Painting and Decorating" are so relevant that they may well be quoted :—

"DRYING OF PAINT.—The drying of paint is an important factor in its durability, and in its successful application. Paint is not dry immediately it appears to be so to the touch ; indeed, the drying process in oil colours goes on as long as the life of the work permits, getting less and less perceptible as the amount of oxygen taken up by the oil is smaller and smaller, until at last the paint becomes a brittle and useless shell of dead pigment. It is important that a certain amount of this oxidisation should take place in the undercoats before they are covered and shut in by the later coats, as during the first and rapid portion of this 'drying,' as we term it, the process is accompanied with a considerable amount of movement and shifting of the particles of colour. If a piece of work be painted coat upon coat of oil colour before each coat is sufficiently dry, this movement will cause the top coat to break up and open out under a voluntary effort of the under-coats to obtain the necessary oxygen for their proper hardening. Four days is not too much to allow for the proper drying of oil colour which will nominally 'dry' in twenty-four hours. The period may be shortened by additional driers, but a good rule is to allow all paint to stand four times as long as it takes to arrive at superficial dryness."

And again :—

" TIME FOR OUTSIDE PAINTING.—The time for outside painting is largely a matter of opinion. The writer considers that the summer time is undoubtedly the best time, because of the absence of dampness in the atmosphere, and the equable temperature of the nights. Spring and autumn come next. No outdoor work should be attempted in frosty weather. Frost destroys the quality of the oil on which the stability of the work depends, and drives moisture deep into the woodwork."

THE PREPONDERATING INFLUENCE OF HUMIDITY.

Although atmospheric temperature undoubtedly exerts an influence on the drying of paint, its influence is in general considerably over-rated. On the other hand, the part played by moisture in the air in retarding the drying of paint hardly gets the attention it deserves. A somewhat close scrutiny of the local conditions that accompanied the drying of a large number of samples of paint applied over a fairly long period has convinced me that *the humidity* (or, to use the converse term, *the dryness*) of the air is one of the dominating conditions that control the drying of paint.

How many cases of bad drying can one trace to an excessive proportion of moisture in the air ? A room is plastered. The air in the apartment is saturated with water vapour. A fire is lit. The temperature rises ; the air is saturated with moisture, but now at the higher temperature, so that the air contains more moisture than it did before. Some woodwork is painted ; the windows and doors are carefully closed to keep in the heat. The temperature gradually falls, the moisture deposits on every cold surface, the paint does not dry. Bad paint !

As a rule, the question of humidity in connection with inside work is more or less under control, that is if the moisture arises from walls, foul air, etc. Efficient ventilation is the key to the solution of that problem. In the case of outside work exposed to direct climatic influences the painter is in the hands of natural forces, and it may be necessary in many cases to increase the proportion of driers in the paint in order to overcome the defective drying conditions. When the painter finds bright cold articles, such as sheets of glass, steel plates, or water bottles becoming dimmed by the deposition of moisture, then he has an indication that the air is laden with water vapour, and he may be counselled to look out for trouble in the drying of his paint.

The Essential Features of a Satisfactory Paint Drier.

The drier should be in a liquid form, and the liquid should be turpentine, containing a suitable proportion of oil and hard resin *free from lead and rosin.* Many of the so-called modern zinc driers consist simply of resinate of manganese, containing a large excess of free rosin dissolved in turpentine or turpentine substitute. Such materials are very crude driers, although they may be very strong ones.

After exhaustively examining most of the zinc driers and terebines on the market, I have come to the conclusion that the proper drier to use for oxide of zinc paints is a product which can be made only by a skilled varnish maker, and, moreover, only by a varnish maker who has given special attention to the manufacture of terebines and liquid driers in their most modern developments. Such a drier as I have in mind is imitated perhaps more nearly by some of the American Japan driers than by any of the liquid driers now on the British market. The requirements for a good liquid drier for zinc paints are :—

(1) A pale colour, which will neither discolour white paint nor cause the paint to ultimately darken.

(2) Freedom from lead compounds and free rosin.

(3) Capacity to cause the paint to dry under fair conditions within 18 hours if used in the standard proportion, as stated in the various formulæ which follow.

(4) To be of such a nature that if the drying conditions are adverse an addition of 50% more of the drier will not injure the paint.

From this description a practical varnish maker with experience in the manufacture of liquid driers will be able to turn out an article which ought not to cost the user of paints more than 7s. 6d. to 8s. per gallon, and which will be thoroughly satisfactory for all that it is required to accomplish. I have experimented with a drier made according to the principles stated, and have found it eminently satisfactory in use.

RELATIVE PROPORTION OF DRIERS TO OIL.

It has already been stated that the proportion of driers should vary according to the relative proportion of oil present in the mixed paint. There is, however, a certain limit below which we must not go, and there is also a certain maximum limit. The particular drier referred to in the formulæ is one which was mild enough in action to render it possible for the painter to increase with discretion the quantity, if necessary, without having to fear disastrous results, and as the drier contained both hard resin and oil, it partook of the nature of a "binder," which is a considerable advantage in the case of flat coats.

The average proportion of drier may be taken as 4 to 5% of the total weight of paint. This may be reduced to 3% or even less in certain cases, or may be increased to 7½%. In extreme cases where ordinary linseed oil is used even 10% may be necessary.

CONCLUSION.

Having traversed the preliminary ground, we are now in a position to consider typical formulæ suitable for specific conditions. It may be stated in this connection that not only has American and the best Continental practice been reviewed, but existing British methods have been carefully compared, as it is only after examination of a great number of samples that anything like a general rule can be formulated. The formulæ and suggestions which follow may therefore be considered as the results of actual practice adapted to British conditions and requirements.

PAINT MIXTURES AND SPECIFICATIONS

(N.B.—The figures in the following formulæ refer to parts by weight.)

(1)

Specification for Oxide of Zinc Ground in Oil.

The paint to consist only of Genuine Oxide of Zinc (of a quality equal to the Company's Seal Brand), finely ground in pure pale refined linseed oil of good drying power. The proportion of oil in the paint to be 20 per cent. on the weight of the paint.

(2)

Specification for Prepared Drying Oil.

Genuine Pale Linseed Oil well tanked and free from albuminous and suspended matter, treated with not more than 0.5 per cent. and not less than 0.25 per cent. of borate or linleate of manganese, and capable of producing a skin in 18 hours under fair drying conditions.

(3)

Specification for Liquid Zinc Driers.

The colour to be pale, and incapable of staining or darkening zinc white paint.

The drier to consist only of pure linseed oil, turpentine, hard resin and drying salts of manganese.

The drier to be free from lead compounds and rosin.

The drying power to be such that 5 parts of drier added to 100 parts of raw linseed oil will produce a dry skin in 18 hours under fair drying conditions.

(4)

OXIDE OF ZINC PAINT.—TYPICAL MIXING FOR GENERAL WORK ON SURFACES ALREADY PAINTED OR AS FINISHING OIL COAT.

Oxide of Zinc in Oil	100
Linseed Oil	24
Turpentine	6
Driers *	3

NOTES.– (1) In all the formulæ "linseed oil" stands for either ordinary linseed oil or the prepared drying oil. If the latter oil is adopted the proportion of driers may be reduced as a rule by one-third or one-half, but whatever reduction is made in the weight of the driers must be added to the turpentine in order that the consistency of the paint may remain correct.

(2) In cold and humid weather prepared linseed oil should be used by preference, and the driers may be increased according to circumstances up to 50 per cent. more, the turpentine being reduced *pro rata*.

---

* "Driers" in every case indicate "Liquid Zinc Driers" of the nature indicated in Specification (3).

(5)

OIL COAT FOR PRIMING UNPAINTED STONE, CEMENT COMPO WORK AND SIMILAR EXTERIOR PORUS SURFACES.

Oxide of Zinc in Oil	100
Linseed Oil	35
Driers	4

Note.—According to Continental practice, exterior work of the above description is usually finished with 2, 3, or 4 coats of oil colour, without any turpentine except what is present in the drier.

Succeeding coats are based on (5) the total weight being kept the same, as well as the proportion of driers, but the weight of stiff paint being increased and the weight of oil decreased coat by coat.

(6)

Final Oil Coat After (5).

Oxide of Zinc in Oil	115
Linseed Oil	20
Driers	4

This formulæ indicates a paint which is a good deal "rounder" than the average, and which bears out the theory that in protective work zinc paint should be mixed thick and well brushed out. A necessary condition is that the suction has been stopped and the surface "filled" by the preceding coats.

(7)

First Coat for Non-absorbent Exterior Work, Iron, Etc.

Oxide of Zinc in Oil	100
Linseed Oil	15
Turpentine	6
Driers	5

N.B.—To be applied thinly.

(8)

Second Coat on Same Work.

Oxide of Zinc in Oil	100
Linseed Oil	12
Turpentine	9
Driers	4

(9)

THIRD OR FINISHING COAT OF SAME WORK.

Oxide of Zinc in Oil	100
Linseed Oil	18
Turpentine	3
Driers	3

(10)

INTERIOR PAINTING OF NEW WOODWORK.

FIRST COAT.

Oxide of Zinc in Oil	100
Linseed Oil	32
Turpentine	6
Driers	4

Note.—For succeeding coats decrease the oil gradually coat by coat, keeping the stiff paint, turpentine, and driers as above.

(11)

FOR THE FINAL COAT IF REQUIRED GLOSSY.

Oxide of Zinc in Oil	100
Linseed Oil	20
Turpentine	4
Driers	3

(12)

FOR THE FINAL COAT IF REQUIRED HALF FLAT.

Oxide of Zinc in Oil	100
Linseed Oil	10
Turpentine	14
Driers	3

(13)

EGGSHELL FLAT OR PREPARATION FOR ENAMEL.

(INTERIOR WORK.)

Oxide of Zinc in Oil	100
Linseed Oil	4
Turpentine	22
Driers	3

(14)

TRUE FLATTING.

Oxide of Zinc in Oil	55
Oxide of Zinc in Turps	32
Linseed Oil	nil
Turpentine	10
Driers	3

Note.—The use of oxide of zinc ground in turpentine as an ingredient of flatting is an important practical " wrinkle " well known to French and a few English painters. It is hardly possible to obtain a true " flat " with oxide of zinc except by this means.

THE USE OF MIXING-VARNISHES.

Mixing-varnishes, both for inside and outside use, are popular among some users of paints. If they are of good quality these materials have a certain value, but they often serve as a cloak to hide some imperfection. If the prepared oil and liquid driers already referred to are adopted, mixing varnishes will rarely, if ever, be necessary; should they be used they must be reckoned as "oil" in the proportions.

ON KEEPING OXIDE OF ZINC PAINT.

Oxide of zinc paint should not be allowed to remain in contact with the air. When a portion of the paint is taken from a stock keg the remainder should be carefully smoothed down at once, and should on no account be covered with water.

A little linseed oil may be placed on the surface, but the best protection is a circular piece of oiled paper cut to fit the package and placed on the surface of the paint.

IS IT UTOPIAN?

Hitherto we have been dealing mainly with facts. Is it permissable in conclusion to offer a suggestion and to express a hope?

It is almost a truism in every art and handicraft that the more familiar the craftsman is with the appliances of his craft the greater is the success which he achieves. In oxide of zinc the house-painter, the decorator, the user of paint generally, has a material which well repays any special attention bestowed upon it. Familiarity with its nature and properties will enable the craftsman of modern tendencies and unprejudiced mind to accomplish much that he may well be proud to point to as his handiwork.

But it is not merely a question for the painter and the user of paints. The matters discussed, in a manner necessarily condensed, in the preceding pages will be seen to directly concern the oil-boiler, the paint grinder and the varnish maker. If representatives of all these important industries were to join forces with the up-to-date painter it might safely be predicted that the existing problems in connection with the use of oxide of zinc as a painter's material would in a comparatively short space of time be things of the past.

INDEX

PAGE

Absence of Metallic Impurities in Oxide of Zinc 16
Admixture of Oxide of Zinc with other Pigments .. 24
Advantages of Oxide of Zinc 39
American Oxide of Zinc .. 20
American Ready Mixed Paints 59
Amount of Driers in Zinc Paints 54
Anti-fouling Paint 27
Anti-rust Paint 73
Application of Zinc Paint .. 33
Application of Paints, Conditions Peculiar to .. 82
Applications of Oxide of Zinc 40
Arsenic in Oxide of Zinc .. 14
Asbestine 25
Asbestos, Powdered .. 27
Author's Preface 9

Barium Sulphate 26
Barium Sulphate, Zinc and Lead 37
Barytes 25
Barytes 26
Benzoated Lard 79
Best Oil Medium, the 95
Bismuth and Oxide of Zinc .. 14
Blending of Pigments .. 25
Board of Trade Regulations.. 49
Body 64
Boiled Linseed Oil, Pale .. 23
Borate of Manganese .. 89

Cadmium in Oxide of Zinc .. 14
Calcium Sulphate, Hydrated 26
Camphor Gum 77
Casein Flexible White Paint.. 75
Casein Paints 76
Casein Waterproof White .. 80

PAGE

Celluloid Solution 77
Cheap Zinc Primer 68
Chinese Wood Oil 51
Coarse Pigments 66
Colours, Superfine 71
Commercial Oxide of Zinc .. 14
Common Casein White Paint 75
Comparative Experiments .. 57
Compounds of Lead 52
Conditions Peculiar to the Application of Paints .. 82
Continental Makes of Stiff Zinc Paint 91
Continental Oxide of Zinc .. 16
Courtois 17
Covering Power of Oxide of Zinc 56
Covering Power 64
Cracking 46

Dipping Paints 68
Disadvantages of Oxide of Zinc 39
Distinction between Lead and Zinc Stiff Paints .. 91
Dioxide of Manganese .. 89
Driers, Amount of 54
Driers 82
Driers for Oxide of Zinc .. 41
Driers, General Remarks on 88
Drying Material in Mixed Oxide of Zinc Paint .. 94
Drying of Paints, Humidity as affecting 96
Drying of Oxide of Zinc .. 51
Drying of Zinc Paints .. 50
Drying Oil, Manganese .. 53
Drying of Oxide of Zinc .. 23
Durability of Oxide of Zinc Paints 44
Durability 57

PAGE
Editor's Introduction .. 5
Eggshell Flat 85
Eggshell Gloss 59
Elastic Ivory White Paint .. 70
Enamels 27
Enamel, Preparation for .. 44
Enamel Paints 27
Essential Features of a Satisfactory Paint Drier .. 99
Essential Points in a Protective Paint 45
Excess of Oil 58
Exterior Work 43

Fine Grinding 66
Finely Powdered Asbestos .. 26
Finishing Coat Glossy .. 44
Finishing Coat 43
Final Oil Coat 104
First Coat for Non-absorbent Exterior Work 104
Fireproof Paints 27
Flat Paints 33
Flatting 34
Formaldehyde 80

Galvanized Iron, Paint for .. 26
Genuine Oxide of Zinc Ground in Oil 88
Gloss Zinc 70
Green Seal Oxide of Zinc .. 20
Grinding, Notes on 19
Gypsum 25
Gypsum 26

Historical Notes 17
H.M. Office of Works .. 38
Humidity and Temperature as Affecting Drying of Paints 96
Hydrated Calcium Sulphate .. 26
Hygienic Aspects of Zinc Paints 48

Imitation "Slate Roofing" Paint 74
Indifferent Linseed Oil .. 91
Industrial Applications of Zinc 40
Influence of Humidity .. 103
Introduction by the Editor .. 5
Interior Painting 105
Interior Work 44
Inert Pigments 46
Iron, Painting on 59
Ivory White Paint, Elastic .. 70

Japan Colours 71

Laboratory White Paint .. 68
Lead and Stiff Zinc Paints, Distinction Between .. 86
Lead, Barium Sulphate and Zinc 37
Lead in Oxide of Zinc .. 14
Lead Poisoning 48
Lead Soap 58
Legal Aspects of Zinc Paints 48
Linoleate Manganese .. 43
Linoleate of Manganese .. 89
Linseed Oil 51, 82
Linseed Oil, Indifferent .. 91
Linseed Oil, Pale Boiled .. 23
Linseed Oil, Per Cent. of .. 19
Liquid Drier, Requirements of a Good 105
Liquid Zinc Driers, Specification for 102
Lovibond's Tintometer .. 60

Manganese Compounds .. 53
Manganese, Linoleate of .. 43
Manganese Resinate, Percentage of 55
Matt Enamel White .. 78
Medium Paste 67
Metallic Zinc 14
Metal Roofs, Paint for .. 74
Miscellaneous Uses of Oxide of Zinc 65
Mixing Oxide of Zinc .. 35
Mixed Paints 31
Mixed Paints, tampering with 32
Moisture, Penetration of .. 46
Moisture in the Air 103

Notes on Grinding 19
Notes, Historical 17
Nut Oil 51

PAGE
Oil, Per Cent. of 19
Oil Coat for Priming Unpainted Stone 103
Oil Colours 66
Oil in the Paint 90
Oil used in Grinding 21
Oil, Excess of 58
Oil Medium, the Best .. 90
Oleo-casein White Paint .. 76
Outside Painting, Time for .. 98
Oxide of Zinc Paint 103
Oxide of Zinc, Miscellaneous uses of 65
Oxide of Zinc Ground in Oil .. 102
Oxide of Zinc Ground in Oil .. 89
Oxide of Zinc from the Legal, Hygienic and Social Standpoints 48

Paint Drier, the True Role of 95
Paint Film 99
Paint Mixtures and Specifications 107
Paint, Thinning the Stiff .. 97
Paint Film, Penetration of Moisture 46
Paint for Galvanized Iron .. 26
Paint for Metal Roofs .. 74
Paints, Enamel 27
Painting Paper and other Flexible Substances .. 78
Painting a Wood Surface .. 59
Paint Mixtures and Specifications 102
Painting on Iron 59
Paints, Mixed 31
Pale Boiled Linseed Oil .. 23
Paper Box White 78
Paste Primer 69
Paste Driers 42
Patent Driers 42
Penetration of Moisture through Paint Film .. 46
Percentage of Manganese Resinate 55
Physical Properties of Dry Paint Films 46
Pigment and Oil, Variations in 84

PAGE
Pigments, Blending of .. 25
Pigments, Mixture with Oxide of Zinc 24
Poisonous Properties of White Lead 50
Poppy Oil 51
Powdered Asbestos 27
Preface, Author's 9
Preliminary Considerations .. 83
Premium White 69
Prepared Drying Oil, Specification for 102
Preparation for Enamel .. 44
Preparation and Mixing of Oxide of Zinc Paints .. 81
Processes for Producing Oxide of Zinc 14
Proportion of Driers to Oil 106
Proportion of Oil in Oxide of Zinc 91
Property Owners' Interest in Paint 13
Protective Paints 27
Putty, Zinc Stopping .. 80
Pure Linseed Oil 58

Qualities Essential in a Protective Paint 45

Radiator White Paint .. 71
Rate of Drying of Zinc Oxide 54
Red Lead Mixtures 74
Red Oxide 63
Red Seal Oxide of Zinc 16, 20
Refined Linseed Oil 21
Relative Proportion of Driers to Oil 106
Requirements for a Good Liquid Drier 105
Resinate of Manganese .. 89

Sandarach Solution 77
Sanitary Zinc White Paint .. 73
Scaling 46
Shellac Solution 76
Ships' Bottom Composition .. 27
Ships' Bottom Composition .. 41
Silicate of Soda 72

PAGE

Silicate Fire and Waterproof Paint 72
Silicate Paints 72
Social Aspects of Zinc Paints 48
Solid Driers 42
Sorel 17
Specification of the Stiff Paint Desirable 86
Specifications and Paint Mixtures 102
Specific Gravity of Oxide of Zinc 16
Spelter 14
Spirit White Enamels .. 76
Stiff Paint, Specification of the 86
Stiff or Thick Paste 67
Stone Mills 67
Substitute for Patent Drier .. 56
Sulphate of Manganese .. 89
Sulphide Zinc White 26
Superfine Colours 71

Tampering with Mixed Paints 32
Technical Applications of Zinc Oxide 40
Tempera Paints 27
Temperature 88
Temperature Affecting the Drying of Paint 101
Terebine 43
Terra Alba 26
Testing the Tint of a Given Pigment 62
Tetroxide of Manganese .. 89
Three-coat Work 39
Thin Coats of Paint Desirable 33
Thinning the Stiff Paint .. 92
Third or Finishing Coat .. 84
Time of Drying 55
Time for Outside Painting .. 98
True Flatting 85
True Role of a Paint Drier .. 99
Turpentine 33
Typical Mixing for General Work 103

Variations in Pigment and Oil 84

PAGE

Varnish in Oxide of Zinc Paints 33
Venetian Reds 62
Vermilionettes 66
Vielle Montagne Co. 18
Vielle Montagne Co. 90

Water Colours 65
Waterproof Paint 72
White Enamel Paste .. 70
White Enamels, Spirit .. 76
White Japan Colour 71
White Lead 26
White Lead Mixed with Manganese Oil 54
White Lead, Poisonous Properties of 50
White Paint. Casein Flexible 75
White Paint, Laboratory .. 68
Whitewash, Zinc 73
Whiting 25
Wood, Painting on 59
Wood Panels 58
Workmen's Compensation Act 48

Yellow Ochre 61

Zinc Adhesives 79
Zinc and Lead Mixed .. 37
Zinc Cementite 77
Zinc Enamel 57
Zinc Oxide, Advantages of .. 39
Zinc Oxide, Admixture with other Pigments 24
Zinc Oxide, Covering Power of 56
Zinc Oxide, Disadvantages of 39
Zinc Ointment 65
Zinc Ointment 79
Zinc Ore 15
Zinc Paint, the Drying Material in 98
Zinc Paints, Preparation and Mixing of 86
Zinc Stopping Putty .. 80
Zinc Whitewash 73
Zinc White 17
Zinc Roof Paint (Grey) .. 69

UC SOUTHERN REGIONAL LIBRARY FACILITY

A 000 030 292 7

Mathews'

Permanent Red

(Absolutely fast and non-bleeding). In Oil, Turps and Goldsize.

Permanent Maroon

In Oil, Turps and Goldsize.

Permanent Olive Green.

Finest Ground and Strongest Stainers.

Ochres, Umbers, Vandyke Brown, Siennas, Etc., Etc.

John Mathews & Co.,
Hatton Garden,
Liverpool.

Telegrams—
"MATHEWS, LIVERPOOL."

Telephone—
"784 CENTRAL" (3 Lines.

Contractors to H.M. War Office and Admiralty.